A GUIDE TO THE SPECIES OF THE GENUS *EUPLOTES* (HYPOTRICHIDA, CILIATEA)

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A GUIDE TO THE SPECIES OF THE GENUS *EUPLOTES* (HYPOTRICHIDA, CILIATEA)

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INTRODUCTION

ALTHOUGH species of the genus *Euplotes* Ehrenberg, 1830 are frequently observed in both marine and freshwater samples it is often not possible for the protozoologist to make specific identifications. This difficulty is due to at least three major factors ; firstly, many of the features used for distinguishing species within the genus are known to vary considerably even within clonal cultures, secondly, there is a large amount of confusion in the literature concerning the identity of certain common species and thirdly, there is the added difficulty of having to search through a considerable body of literature before an identification can be attempted. It is hoped that the present paper will help solve some of these problems by gathering together descriptions and diagrams of all those organisms considered to be distinct *Euplotes* species. Naturally the serious worker will still wish to refer to the original material but the volume of literature needed to be examined should be significantly reduced. The revisions of Tuffrau (1960) and more recently the species lists of Borror (1972) have been of considerable value but one is still left with the problem of searching through a large amount of original papers. Finally, to the author's knowledge no attempt has been made to devise a key to the species of *Euplotes* since that of Kahl (1932).

FEATURES OF TAXONOMIC IMPORTANCE

In the past 200 years over 80 species and varieties of the genus *Euplotes* have been described. Until relatively recently the species were separated simply on a basis of body size and shape, on the dorsal and ventral ridges and on the arrangement of the cirri on the ventral surface. Several decades were to pass after the introduction of the 'wet' silver impregnation method by Chatton and Lwoff (1930) before Tuffrau (1954) first discovered that the silver-line system or argyrome might be of taxonomic importance for species determination in the genus *Euplotes*. Tuffrau (1954) first suggested that the numbers of dorsolateral rows of cilia, the geometry of the argyrome, the number of frontoventral cirri and the form of the macronucleus could be used to distinguish species and later (Tuffrau, 1960) he presented his revision of the genus based on these ideas. Since that revision more species have been redescribed and confirmed on the basis of silver preparations (principally Borror 1962, 1963, 1968a) and several new species have been introduced. Borror (1972) published a list of species he found acceptable based on modern criteria together with their probable synonyms. In general the present author's findings confirm those of Borror (1972) although there are several instances where changes have been suggested. Carter (1972) added four new species to the list of Borror (1972) and redescribed seven others, furthermore he was able to suggest from his investigations that the shape of the adoral zone of membranelles (AZM) and the number of membranelles therein were also useful additional features for separating species within the genus.

It is unfortunate that of the taxonomic characters mentioned above only one – the gross geometry of the dorsal argyrome – remains constant. All other features have been reported to vary to a greater or lesser extent and an account of some of these variations follows. However, the application of these modern criteria now makes it possible to examine and reappraise the species and varieties within the genus.

(*a*) *General morphological and ecological features*

Although Kahl (1932) used the habitat of *Euplotes* species as a strict taxonomic character he was ill advised to do so since several species are known to be euryhaline. However, specialized habitats such as the digestive tracts of sea urchins may be useful for species determination. To date only two species have been recorded in urchins, *E. balteatus* (Dujardin, 1841) which may be found both as a commensal and free-living and *E. tuffraui* Berger, 1965 which seems to be limited to a commensal mode of life. The size of a *Euplotes* species can be used as a taxonomic feature but must be applied with extreme caution. It is true that the smallest species never attain the size of the largest species and *vice versa* but it is also known that the size of a ciliate may vary with several parameters including its rate of growth (Curds, West and Dorahy, 1974), the concentration of food (Curds and Cockburn, 1971) and kind of food (Giese, 1938; Tuffrau, 1964). The overall shape of a *Euplotes* species is perhaps a rather more stable feature but is of limited taxonomic value since few species have really characteristic outline shapes.

Dorsal and ventral ridges are sometimes of value in species determination particularly when comparing modern preparations with early descriptions where ridges were often clearly figured. Borror (1968a) discussed cortical sculpturing and suggested that the use of nigrosin-$HgCl_2$-formalin method (Borror, 1968b) might help create a union of old and new species within the genus.

Coloured species of *Euplotes* have been encountered for many years; both Ehrenberg (1840) and Stein (1859) described green species which were likely to be forms of *E. patella* (Muller, 1773). Later Kahl (1932) listed three 'formae' of *E. patella* which contained zoochlorellae. It should be emphasized that one must distinguish between organisms feeding on green algae and those bearing zoochlorellae. Since Kahl (1932) only Diller and Kounaris (1966) seem to have mentioned zoochlorellae in *Euplotes*, and they described *E. daidaleos* Diller and Kounaris, 1966, a species closely related to *E. patella*, as continually containing zoochlorellae and this perhaps is the only valid record although it would be unwise to dismiss the observations of the early workers too readily.

(*b*) *Cirri*

The numbers and arrangement of the cirri on the ventral surface of *Euplotes* have been used as important taxonomic features for many years. Earlier workers recognized four groups of cirri – frontals, ventrals, anals or transversals and caudals – but now the frontals and ventrals are more commonly treated as a single group – the frontoventral cirri (Fig. 1). Several early workers placed a certain amount of faith on the numbers of caudal cirri as a taxonomic character. Kahl (1932), for example, differentiated between varieties of *E. moebiusi* Kahl, 1932 and *E. affinis* (Dujardin, 1841) based on the numbers of caudal cirri and there are many other similar examples. However, modern evidence has clearly shown that variation in caudal cirri numbers is a common feature, and indeed seems to be the rule rather than the exception in certain species. Hufnagel and Torch (1967), for example, demonstrated in clones of *E. vannus* (Muller, 1786) that on division the proter always received five and the opisthe four caudal cirri no matter how many caudals the mother cell originally had ; thus these two morphological variants were found in equal proportions in the total population. Hufnagel and Torch (1967) further

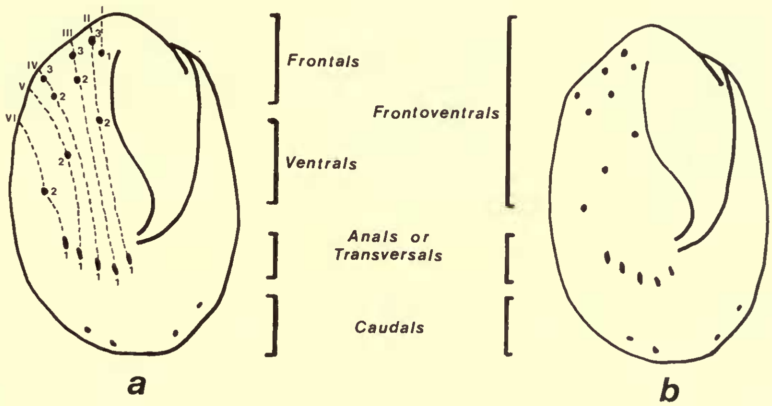

FIG. 1. Ventral cirri of *Euplotes*. a. Wallengren (1900) system of cirrus numeration and older method of naming cirri groups. b. Modern method of naming groups of cirri.

showed that this variation was due to the normal morphogenetic events involved in the development of the right caudal cirri from the right dorsal kineties. In addition Hufnagel and Torch (1967) observed transient abnormal caudal cirrus development in *E. plumipes* Stokes, 1884 (a synonym of *E. eurystomus* Kahl, 1932) although no adults were found with an abnormal number of caudals. It is evident from this type of information that the number of caudal cirri is of little, if any, value in the identification of species of *Euplotes*. The reader is recommended to consult the paper by Frankel (1973) which gives a good short modern account of morphogenesis in hypotrichs.

To the author's knowledge the numbers of transverse cirri have yet to be reported to vary in their number which is remarkably constant throughout the genus. With the exception of *E. strelkovi* Agamaliev, 1967 which has 6 transversals all other species have 5 transverse cirri. The number of frontoventral cirri is of greater use for species determination than the other groups of cirri since although they vary from species to species they remain remarkably constant both in number and in arrangement within a particular species. Most *Euplotes* possess 10 or 9 frontoventral cirri, far fewer have 8 while only *E. raikovi* Agamaliev, 1966 has been reported to have 7 frontoventrals. With the exception of *E. tuffraui* the variation in frontoventral numbers seems to depend upon streak V (Wallengren, 1900 system, see Fig. 1). *Euplotes raikovi* was reported (Agamaliev, 1967) to exhibit intraspecific polymorphism in the number of frontoventrals; he noted that there were 7 or 8 frontoventral cirri and indicated that cirrus V2 (Fig. 1) was that which did not develop in some specimens. Washburn and Borror (1972) described a strain of *E. raikovi* from America in which an eighth cirrus (V2) never developed although they did observe a barren plaque in each case. Curds (1974) recently reported a similar case in his description of *E. parkei* Curds, 1974 where cirrus V2 was present in some and absent from other specimens even within the same clone. The frontoventral cirri of *E. tuffraui* show a wider variation than reported in other species and furthermore the variation is not due to streak V but to streaks III and IV. Berger (1965) stated that the majority of *E. tuffraui* isolated from the digestive tracts of sea urchins possess 8 frontoventral cirri although he found 11 specimens that had 10 frontoventrals which was apparently due to the subdivision of the cirrus bases III 2, III 3 and IV 2. A further two specimens were found with 9 frontoventral cirri where only cirrus bases III 3 and IV 2 were subdivided. With the exception of the examples listed above the number and positioning of the frontoventral cirri nevertheless remain very valuable taxonomic characters that have been widely used in the past and will do so in the future.

(*c*) *The dorsal argyrome*

The overall geometrical pattern of the dorsal argyrome is one feature of taxonomic importance that, to date, has not been reported to vary. Tuffrau (1960) first introduced this feature for taxonomic purposes and he described three general types which he called 'muscicola', 'eurystomus' and 'vannus' after the species in which he first found them. Since that time many more silver-line systems of *Euplotes* species have been described in the literature and it is now possible to divide the dorsal argyrome patterns into five or six types as shown in Fig. 2.

The simplest type (Fig. 2a) includes six species whose dorsal interkinetal argyrome pattern is composed of longitudinal kineties with simple transverse connections between them so that there is a single row of polygons between the dorsal cilia or bristles. This group corresponds to the 'vannus' type of Tuffrau (1960) although it is suggested that the term 'single-vannus' is more descriptive and consistent with the terms to be used later.

The first complication in the dorsal argyrome pattern is shown in Fig. 2b, where the longitudinal rows of polygons are split centrally so that there are two longitudinal rows of polygons, approximately equal in width, between the rows of dorsal cilia. This group corresponds to some of those Tuffrau (1960) called the 'eurystomus' type although it would appear that the organism that this author identified as *E. eurystomus* (Wrzesniowski, 1870) was in fact *E. aediculatus* Pierson, 1943. However, since both of these species have dorsal argyromes of the same overall pattern and since 'eurystomus' type is now a widespread term it is suggested that it is kept but

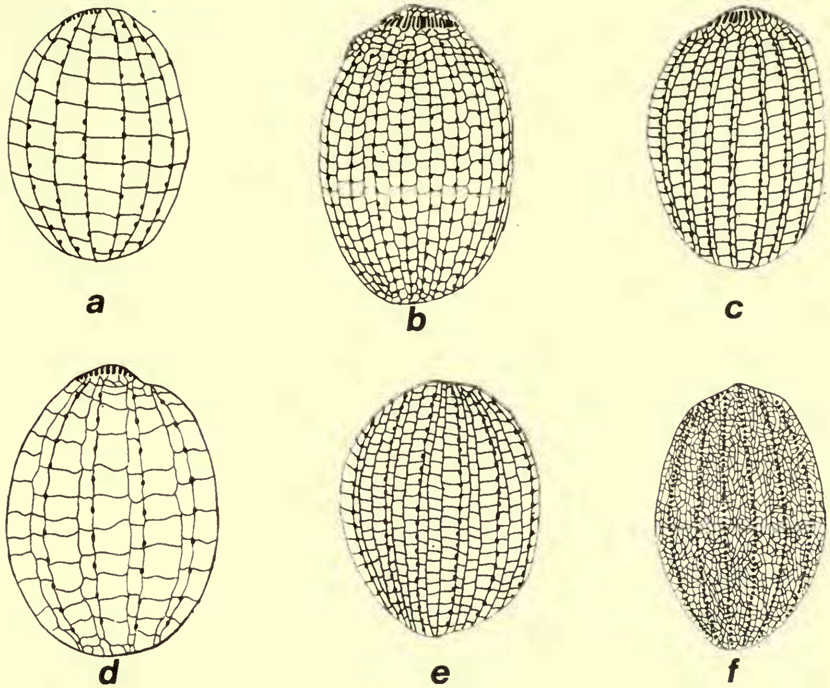

FIG. 2. Dorsal argyrome patterns of *Euplotes*. a. Single-vannus type. b. Double-eurystomus type. c–d. Double-patella types. e. Multiple type. f. Complex type.

expanded to 'double-eurystomus' type which will serve to distinguish that group of 24 species from another group of 8 species which also have double but unequal rows of polygons between the dorsal cilia. Perhaps the best known species in the latter group is *E. patella* (Muller, 1773) which Tuffrau (1960) included in his 'eurystomus' group and for this reason it is suggested that the pattern be called the 'double-patella' type. In this type the rows of polygons (Figs. 2c, 2d), between the dorsal cilia, are obviously unequal in width ; in all but two species the wide rows of polygons are situated on the left of the rows of dorsal cilia (Fig. 2c), but in *E. strelkovi* and *E. zenkewitchi* Burkovsky, 1970 the wide rows are on the right and the narrow rows on the left of the kineties (Fig. 2d). It could be argued therefore that the 'double-patella' type should be further divided into these two sub-types, but this does not seem warranted unless more species whose argyrome patterns conform to the second sub-type are found.

In the present author's opinion the 'muscicola' type of Tuffrau (1960) included a heterogeneous assemblage of dorsal argyrome patterns that should now be divided into two more natural groups. It is therefore suggested that the term 'muscicola' type be discontinued and replaced by the terms 'multiple' type and 'complex' type. When the dorsal argyrome patterns of these two types are examined it can be seen that (Figs. 2e, 2f) the tendency for the rows of polygons to become further subdivided is continued so that the next complication is that 3 or 4 regular rows of polygons of equal width may be found between the rows of dorsal cilia (Fig. 2e) and these conditions are found in *E. indentatus* Carter, 1972 and *E. muscicola* Kahl, 1932 respectively. It is suggested that argyrome patterns such as these be called 'multiple' types.

The final complication in dorsal argyrome patterns is that the polygons become so subdivided that an irregular network or mesh is formed between the dorsal cilia so that distinct rows of polygons cannot be distinguished. It is suggested that this pattern be called the 'complex' type (Fig. 2f). The latter pattern is illustrated well by the species *E. gracilis* Kahl, 1932, *E. muscorum* Dragesco, 1970 and *E. elegans* Kahl, 1932 but not so well by *E. moebiusi* the fourth member of the group. In *E. moebiusi* the dorsal argyrome consists of a mixture of well-defined regular polygons interspersed with an irregular meshwork.

With two exceptions the dorsal argyrome patterns of the species of *Euplotes* that have been described to date fit neatly into the types outlined above. One of these exceptions, *E. moebiusi* has already been mentioned and can readily be fitted into the 'complex' group by the presence of an irregular meshwork between the dorsal cilia. The other exception, *E. tegulatus* Tuffrau, 1960, which was previously placed in the 'eurystomus' type (Tuffrau, 1960) is more difficult since it could almost equally well be fitted into the 'double-eurystomus' or 'multiple' groups. In the case of *E. tegulatus* the dorsal argyrome pattern (see Fig. 46) consists of two longitudinal rows of large polygons between the dorsal cilia as in *E. eurystomus* but here there is also a central regular line of narrow elongate polygons. *Euplotes tegulatus* therefore displays what could be interpreted as an intermediate stage between the typical 'double-eurystomus' type and the typical 'multiple' type as shown in *E. indentatus*. In the author's opinion it seems more appropriate to place this species in the 'multiple' type group and reserve the 'double-eurystomus' type group solely for those species with two equal rows of polygons between the kineties.

Whereas the overall geometrical pattern of the dorsal argyrome appears to be a completely stable feature, the number of dorsolateral kineties has been reported to vary in several species including the following ; *E. polycarinatus* Carter, 1972 (20–21 kineties), *E. variabilis* Stokes, 1887 (a synonym of *E. eurystomus* Kahl, 1932, 8–12 kineties), *E. eurystomus* (a synonym of *E. aediculatus*, 8–9 kineties) (see Carter, 1972, for all three species), *E. vannus* (8–9 kineties, see Heckmann, 1963), *E. mutabilis* Tuffrau, 1960 (11–13 kineties, see Tuffrau, 1960), *E. eurystomus* (8–9 kineties, see Bonner, 1954) and *E. tuffraui* (9–10 kineties, see Berger, 1965). However, in the majority of species the number of dorsolateral kineties remains constant. In the case of *E. mutabilis*, Tuffrau (1960) concluded that the variation in the number of kineties was accidental and exceptional, although even accidental variations seem to be widespread in nature. In single clonal cultures Bonner (1954), Carter (1972) and Heckmann (1963) have all reported instances of variation in the number of dorsolateral kineties. Furthermore, Carter (1972) found in three strains of *E. eurystomus* (a synonym of *E. aediculatus*) that the number of kineties was constant within the clone but different from clone to clone. In spite of variations such as these the number of kineties in most cases is a good reliable taxonomic character.

The numbers of kinetosomes or dorsal cilia plaques are more variable than those of kineties, even so variation within the clone is frequently much less than from species to species. Although several authors have recorded the number of dorsal cilia and by doing so have inferred that they are of taxonomic value no one has yet suggested this number to be of real taxonomic importance. In the key that follows the number of dorsal cilia has been used frequently but only when the numbers are sufficiently different to warrant their use. In each case the approximate range in the mid-dorsal kineties (where they are most numerous) are given.

(d) The ventral argyrome

The gross geometry of the ventral argyrome is of little taxonomic value since distinctive patterns are not immediately recognizable. However, some authors have used the general size of the constituent polygons on a comparative basis and this may be given as additional information. Silver-line preparations of the ventral surface display the infraciliary network, the cirri plaques and the adoral zone of membranelles (AZM) which is of kinetosomal origin. Whereas in the past the size and shape of the AZM have often been used as taxonomic features, the number of membranelles therein has only recently been introduced. Carter (1972) found, in 11 species that he studied, that the AZM features were even more stable than those characters suggested by Tuffrau (1960). However, all the features of the AZM are known to vary and the classic example is that of *E. balteatus* which exhibits polymorphism depending upon the nature of the food supply. Tuffrau (1964) found that both the size and shape of the AZM of *E. balteatus* was dependent upon the size of the cell and the number of membranelles in the AZM varied from 25 to 30 in small cells and from 70 to 80 membranelles in the case of giant individuals. Fortunately variation of this magnitude seems to be confined to that species, nevertheless variation in the number of membranelles is commonly observed. For this reason the approximate ranges of membranelle numbers are given and their use has been restricted to cases when there is a considerable difference in the numbers between two species, for example when distinguishing *E. minuta* Yocum, 1930 (30–40 membranelles) from *E. vannus* (60–70 membranelles).

(e) Nuclear features

The protozoan nucleus has been used as an important diagnostic character in taxonomic schemes for many years and the dimorphic nuclei of ciliates have played an important part in ciliate taxonomy. The macronucleus of *Euplotes* is elongate and takes a variety of shapes which differ from species to species. Perhaps the most common form is the simple inverted **C**-shape while in others this has become modified to a **3**-shape and in others the arms close to form a hoop- or horseshoe-like structure. In addition, several rather more bizarre forms are known. The micronucleus is usually small and round but it does vary in size and shape and in *E. tegulatus* and *E. aberrans* Dragesco, 1960 the micronucleus is particularly large.

The use of the shape of the macronucleus as a diagnostic feature in the genus *Euplotes* has been the subject of discussion for several years. Tuffrau (1960) supported the view that the nuclear features were of great taxonomic importance provided the shape of the macronucleus was determined when in a 'quiescent state', that is to say when neither division nor conjugation is in progress. It is true to say that the macronucleus of *Euplotes* takes a variety of forms during reorganization and division and it is likely that these phenomena have been responsible for the confusion that has appeared in the literature. Nevertheless, the consensus of opinion seems to be that if the process of reorganization is understood and provided it is possible for the taxonomist to recognize the interphase macronucleus from one that is in another divisional state, then the interphase macronucleus is constant and characteristic of the species. The interphase macronucleus can be recognized by the presence of replication bands (Gall, 1959; Kluss, 1962; Prescott, Kimball and Carrier, 1962) which represent bands of DNA synthesis travelling from the two nuclear extremities towards the centre of the macronucleus. Prescott *et al.* (1962) showed that the macronucleus of *E. eurystomus* is in interphase when the replication bands are present along the macronuclear arms from tips to half the distance to the centre.

KEY TO THE GENUS *EUPLOTES*

It is unfortunate that silver-line preparations have not yet been made and described for all species of *Euplotes*. The key that follows relies heavily upon features displayed by the silver-line technique but a series of descriptions of undesignated species follows the key (Section F, p. 50) and this includes all those species whose silver-line systems have not yet been described. Diagrams of silver preparations are given for all species where available and these have been obtained directly from original descriptions. Unless otherwise specified all scales given on diagrams indicate 10 μm. The characters for the key were selected and used in order of least variation. Therefore the first division of species into groups is made on a basis of the overall pattern of the dorsal argyrome and further subdivisions are made using the number of frontoventral cirri and dorsolateral kineties. Wherever possible, reported variations of a feature within a species has been taken into account; thus it is possible to identify *E. mutabilis* when it has a 'single-vannus' type argyrome or when undergoing reorganization and therefore appears to have a complex argyrome. Similarly it should be possible to identify *E. eurystomus* when it has any of the reported numbers of dorsolateral kineties and so on.

KEY TO THE MAJOR GROUPS OF SPECIES

1 a Single-vannus type dorsal argyrome (Fig. 2a) with single row of polygons between kineties . . . . **5** (Section A, p. 11)

b Some other type of dorsal argyrome **2**

2 a Double dorsal argyrome (Figs. 2b, 2c, 2d) with two rows of polygons between kineties **3**

b Multiple or complex dorsal argyrome (Figs. 2e, 2f) **4**

3 a Double-eurystomus type dorsal argyrome (Fig. 2b) with two rows of equal-sized polygons between kineties . . . . **10** (Section B, p. 16)

b Double-patella type dorsal argyrome (Figs. 2c, 2d) with alternate rows of wide and narrow polygons between kineties . . . . **36** (Section C, p. 38)

4 a Multiple type dorsal argyrome (Fig. 2e) with several (more than two) regular rows of polygons between kineties . . . . **43** (Section D, p. 45)
b Complex type dorsal argyrome (Fig. 2f) with irregular meshwork of small polygons between kineties . . . . **45** (Section E, p. 47)

Section A. Key to species with a single-vannus type dorsal argyrome

5 a 8 or less dorsolateral kineties **6**
b 9 or more dorsolateral kineties **7**
6 a 6 dorsolateral kineties with 7–10 dorsal cilia in central rows . . . *E. balticus*
b 8 dorsolateral kineties with 11–15 dorsal cilia in central rows . . . *E. cristatus*
7 a 9 dorsolateral kineties **8**
b 10 or more dorsolateral kineties **9**
8 a About 22 dorsal cilia in central kineties and 60–70 membranelles in AZM . *E. vannus*
b About 13 dorsal cilia in central kineties and 30–40 membranelles in AZM . *E, minuta*
9 a 10 dorsolateral kineties with 26–30 dorsal cilia in central rows . . . *E. crassus*
b 11 dorsolateral kineties with 11–15 dorsal cilia in central kineties . *E. mutabilis*

Section A. Descriptions of species

Euplotes balticus (Kahl, 1932) Dragesco, 1966

Kahl (1932) first described this species as *E. vannus* var. *balticus* while later Tuffrau (1960) considered it to be a synonym of *E. crassus*. However, the silver preparations of Dragesco (1966) make it clear that *E. balticus* is a distinct species.

Diagnosis. *Euplotes balticus* (Fig. 3) is a medium-sized (60–100 μm long) ovoid marine species. The peristome is long and narrow extending down to about $\frac{4}{5}$ of the body length with the AZM containing about 50 membranelles. There are 10 frontoventral, 5 transverse and 4 or 5 caudal cirri. The ventral argyrome consists of a few very large irregular polygons. The dorsal argyrome is of the single-vannus type with 6 dorsolateral kineties carrying about 10 dorsal cilia in the central rows. The macronucleus is C-shaped with a club-like extension on the posterior arm (Fig. 3b). The micronucleus is situated in a depression of the left anterior edge of the macronucleus. The contractile vacuole may have several satellite vacuoles surrounding it.

Euplotes crassus (Dujardin, 1841) Kahl, 1932

This species was first described by Dujardin (1841) under the name *Ploesconia crassa* Dujardin, 1841. Kahl (1932) noted that *E. violaceus* Kahl, 1928 was in retrospect a synonym of *E. crassus*. The silver-line system was first studied by Chatton and Séguela (1940) and fully described by Tuffrau (1960).

Diagnosis. *Euplotes crassus* (Fig. 4) is a large (100–130 μm long) elongate oval marine species. The dorsal surface is strongly sculptured by 8 longitudinal ridges. The peristome is long and narrow while the AZM consists of about 50 membranelles and extends $\frac{2}{3}$ down the body length. The dorsal argyrome is essentially simple of the single type and there are 10 dorsolateral kineties with the central ones bearing about 26 dorsal cilia. There are 10 frontoventral, 5 transverse and 5 or 6 caudal cirri. The macronucleus is C-shaped with the posterior arm bearing a foot-like

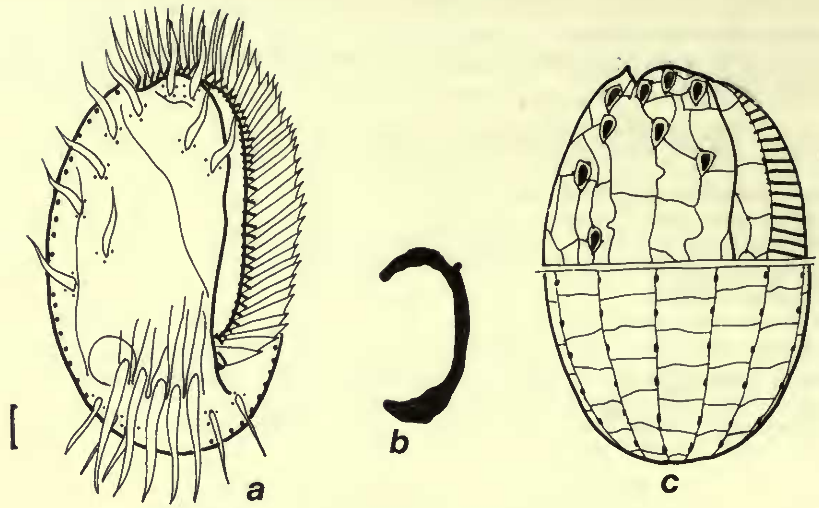

FIG. 3. *Euplotes balticus*. a. Ventral aspect. b. Nuclei. c. Ventral and dorsal argyrome patterns. (After Dragesco, 1966.)

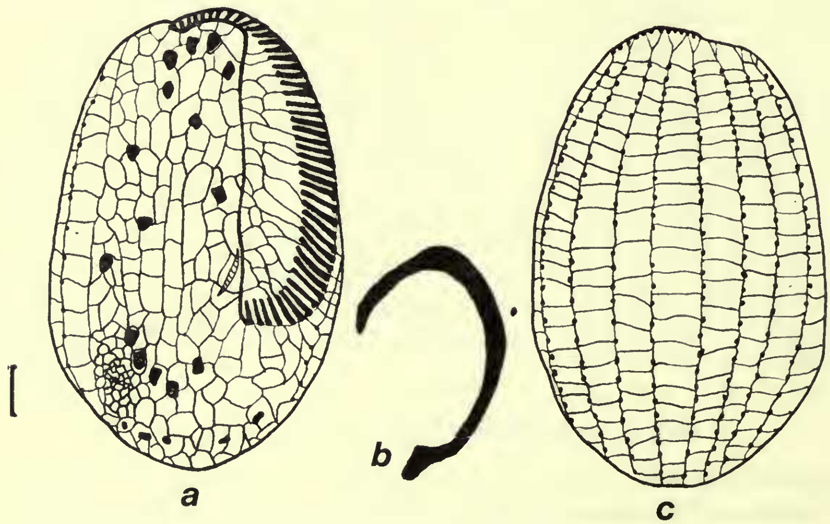

FIG. 4. *Euplotes crassus*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Tuffrau, 1960.)

extension. The compact micronucleus is situated anteriorly near the left edge of the macronucleus.

Euplotes cristatus Kahl, 1932

This species was originally briefly described by Kahl (1932) and subsequently by Tuffrau (1960) and Carter (1972).

DIAGNOSIS. *Euplotes cristatus* (Fig. 5) is a medium (60 μm long, 45 μm wide) oval marine species. The buccal cavity is narrow and almost covered completely anteriorly by the lateral edge of the peristomial lip. The AZM is evenly curved, extends $\frac{1}{2}$–$\frac{2}{3}$ of the length of the body and is composed of 35–47 membranelles. The dorsal surface is convex and there are 6 prominent ridges. The dorsal argyrome is of a simple single type with 8 dorsolateral kineties bearing 11–15 dorsal cilia in the central rows. There are 10 frontoventral, 5 transverse and 4 caudal cirri. In the original description Kahl (1932) noted the presence of only 3 caudal cirri whereas Tuffrau (1960) and Carter (1972) both found 4 caudals. The macronucleus is C-shaped with a heel-like extension on the posterior arm. The small, compact micronucleus is situated on the upper left border of the macronucleus.

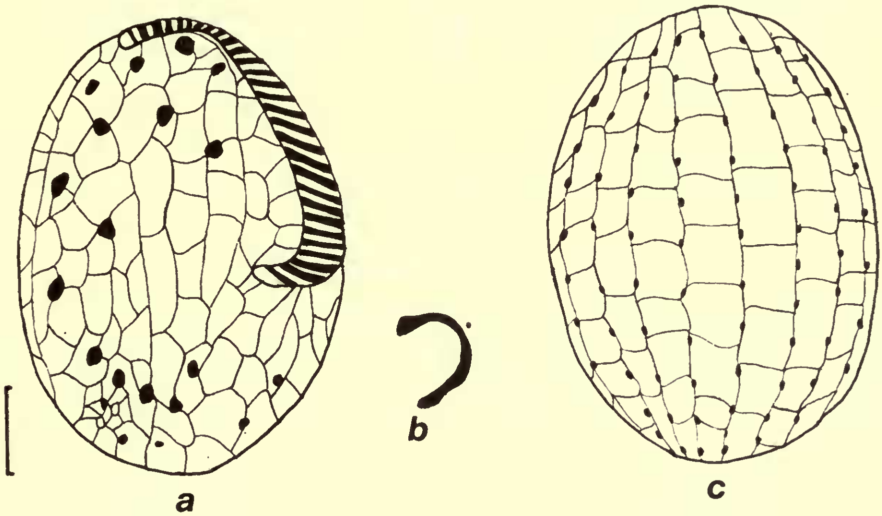

Fig 5. *Euplotes cristatus*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Tuffrau, 1960.)

Euplotes minuta Yocum, 1930

Since the original description of *E. minuta* by Yocum (1930) this species disappeared into obscurity until Borror (1962) rediscovered it and described its silverline system and general morphology.

DIAGNOSIS. *Euplotes minuta* (Fig. 6) is a small (54 μm long, 28 μm wide) oval marine species. The right margin of the peristome is almost straight and extends $\frac{2}{3}$ down the length of the body. The AZM consists of 30–40 membranelles. The dorsal argyrome is of the single type with 9 dorsolateral kineties bearing 12–13 cilia in the central dorsal rows. There are 10 frontoventral, 5 transverse and 4 caudal cirri. The macronucleus is C-shaped with the posterior arm carrying a knob on its left side and a foot-like extension (Fig. 6). The micronucleus is situated anteriorly on the left edge of the macronucleus.

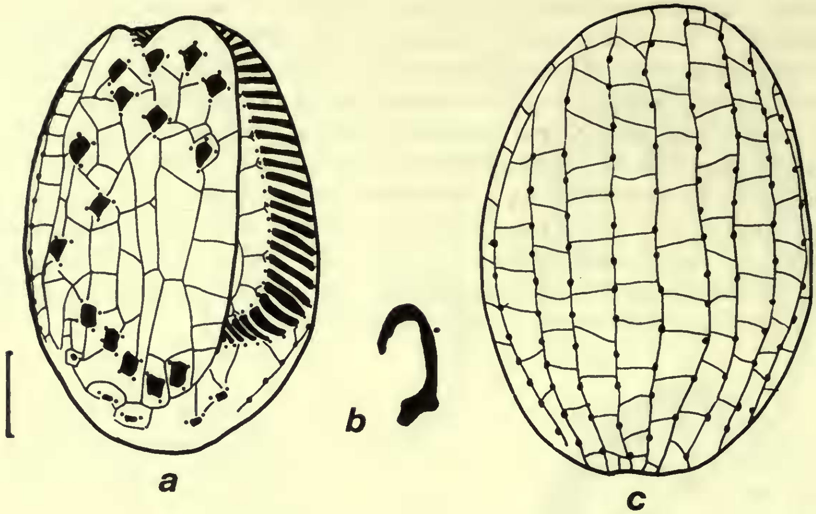

FIG. 6. *Euplotes minuta*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Borror, 1962.)

Euplotes mutabilis Tuffrau, 1960

This species was first found and described by Tuffrau (1960) in his revisionary monograph. Although the dorsal argyrome is of the single type, Tuffrau (1960) generally observed it as is shown in Fig. 7 where reorganization of the kinetosomal network is in progress. Tuffrau (1960) rarely found specimens in the quiescent state which he believed was due to the rapid growth rate of the population that he studied. This species has therefore been included in both single-vannus and complex sections of the key since it would depend on the state of the organism into which group it would appear to fall.

DIAGNOSIS. *Euplotes mutabilis* (Fig. 7) is a medium (95 μm long) oval marine species that is widest at its posterior extremity. The peristome is quite large and the right margin extends unevenly down the body to terminate in a spike-like projection. The AZM contains about 60 membranelles which extend down almost $\frac{3}{4}$ of the body length. The dorsal argyrome is single in the quiescent state but with several irregular ramifications when undergoing reorganization. There are 11 dorso-lateral kineties which bear 12 or 13 dorsal cilia in the central rows. There are 10 frontoventral, 5 transverse and 4 or 5 caudal cirri. The macronucleus is C-shaped with a pointed foot-like structure at the end of the posterior arm. The micronucleus is situated anteriorly.

Euplotes vannus (Muller, 1786) Minkjewicz, 1901

This species has a long history which is given in detail by Tuffrau (1960), and the list of synonyms in Appendix I is indicative of the problems that have arisen in the

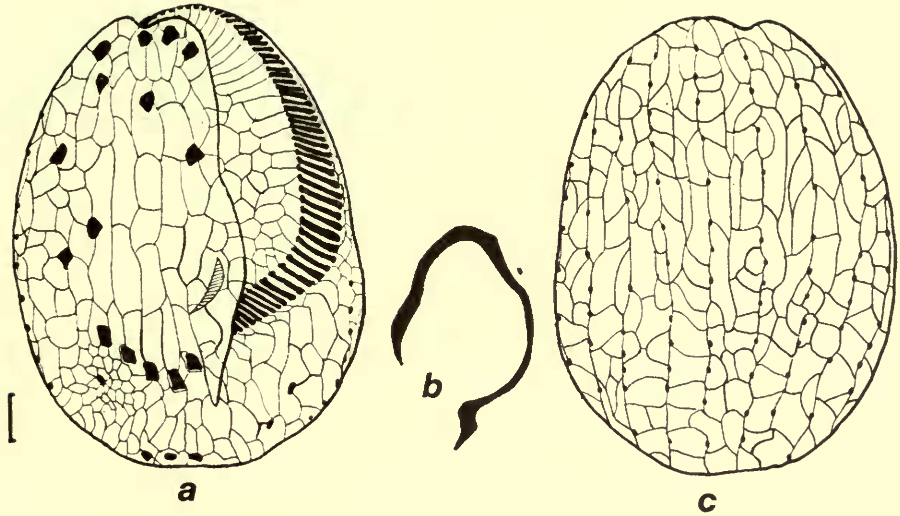

FIG. 7. *Euplotes mutabilis*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome in state of reorganization. (After Tuffrau, 1960.)

past but with the description of the silver-line system by Tuffrau (1960) most of the identification difficulties were eradicated.

DIAGNOSIS. *Euplotes vannus* (Fig. 8) is a medium-sized (75–100 μm long) marine species. It has an overall oval configuration but is slightly curved towards the right. The peristome is narrow but large and the AZM which extends ⅔ down the length of the body contains over 60 membranelles. The dorsal argyrome is of the single type

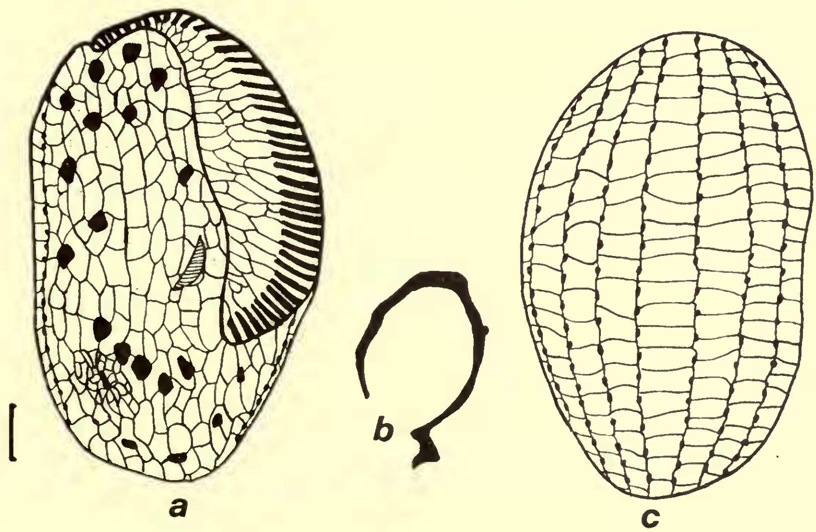

FIG. 8. *Euplotes vannus*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Tuffrau, 1960.)

with 9 dorsolateral kineties carrying about 22 cilia in the central dorsal rows. There are 10 strong frontoventral, 5 transverse and 4 fine but rigid caudal cirri. The macronucleus is an open C-shape with a twisted foot-like extension to the posterior arm. The micronucleus is compact and lies close to and sometimes overlapping the macronucleus.

Section B. Key to species with a double-eurystomus type dorsal argyrome

10 a 6 or 7 dorsolateral kineties **11**
b 8 or more dorsolateral kineties **16**
11 a 6 dorsolateral kineties . . . . *E. latus*
b 7 dorsolateral kineties **12**
12 a Less than 10 dorsal cilia in central kineties . . . . *E. affinis*
b More than 11 dorsal cilia in central kineties **13**
13 a 10 frontoventral cirri **14**
b 8 or 9 frontoventral cirri **15**
14 a 3 caudal cirri, AZM with about 40 membranelles . . . . . *E. octocirratus*
b 4 caudal cirri, AZM with about 20 membranelles . . . . . *E. trisulcatus*
15 a 8 frontoventral cirri . . . . *E. poljanskyi*
b 9 frontoventral cirri . . . . *E. dogieli*
16 a 8 dorsolateral kineties **17**
b 9 or more dorsolateral kineties **25**
17 a 10 frontoventral cirri **18**
b 9 or less frontoventral cirri **22**
18 a Macronucleus C- or 3-shaped **19**
b Macronucleus hoop- or horseshoe-shaped **21**
19 a Slim species, macronucleus 3-shaped . . . . *E. antarcticus*
b Ovoid species, macronucleus C-shaped **20**
20 a 11–15 dorsal cilia in central kineties . . . . *E. alatus*
b 21–25 dorsal cilia in central kineties . . . . *E. crenosus*
21 a Freshwater, 45–55 membranelles in AZM, extra-large cirri bases, 13–17 dorsal cilia in central kineties . . . . *E. magnicirratus*
b Marine or in sea urchins, two forms – a small one with 25–30 and a large one with 70–80 membranelles in AZM, 8–11 dorsal cilia in central kineties . *E. balteatus*
22 a 6–10 dorsal cilia in central kineties **23**
b 16–35 dorsal cilia in central kineties **24**
23 a 8 frontoventral cirri (sometimes 9), 4 caudals and 10 dorsal cilia in central kineties *E. parkei*
b 9 frontoventral cirri, 3 caudals and 6 dorsal cilia in central kineties . *E. bisulcatus*
24 a Macronucleus flat-backed C-shape with micronucleus distinctly separate. AZM straight . . . . *E. aediculatus*
b Macronucleus 3-shaped with micronucleus within a cleft of it. AZM sigmoidal *E. eurystomus*
25 a 9 dorsolateral kineties **26**
b 10 or more dorsolateral kineties **38**
26 a Commensal in echinoids. . . . . *E. tuffraui*
b Free-living **27**
27 a 10 frontoventral cirri, AZM with 25–30 membranelles . . . *E. quinquecarinatus*
b 9 frontoventral cirri, sigmoidal AZM with 46–65 membranelles . . *E. eurystomus*
28 a 9 frontoventral cirri **29**
b 10 frontoventral cirri **31**
29 a Commensal in echinoids, macronucleus C-shaped . . . . . . *E. tuffraui*
b Free-living, 3-shaped macronucleus **30**

30 a 10–12 dorsolateral kineties . . . . *E. eurystomus*
b 14 dorsolateral kineties . . . . *E. amieti*
31 a 10 dorsolateral kineties **32**
b 11 or more dorsolateral kineties **33**
32 a 7–15 dorsal cilia in central kineties, commensal in echinoids . . . *E. tuffraui*
b 21–25 dorsal cilia in central kineties, free-living . . . . . *E. inkystans*
33 a 11 or 12 dorsolateral kineties **34**
b 13 or more dorsolateral kineties **35**
34 a 11 dorsolateral kineties with about 18 dorsal cilia in central rows and 4 caudal cirri *E. neapolitanus*
b 12 dorsolateral kineties with up to 40 (rarely 18–21) cilia in central rows and 5–8 caudal cirri . . . . *E. charon*
35 a 13 dorsolateral kineties with 36–42 dorsal cilia in central rows . . *E. harpa*
b 20–21 dorsolateral kineties with 20–23 dorsal cilia in central rows . *E. polycarinatus*

Section B. Descriptions of species

Euplotes aediculatus Pierson, 1943

Euplotes aediculatus was first described by Pierson (1943). Later both Tuffrau (1960) and Carter (1972) described organisms which were obviously *E. aediculatus* but named them *E. eurystomus*. Pierson, Gierke and Fisher (1968) produced well-documented evidence (Figs. 9, 10) on the differences between these two species.

Diagnosis. *Euplotes aediculatus* (Figs. 9, 10) is a large freshwater hypotrich 105–160 μm long. The peristome is medium sized, triangular and has two depressions in the median border. One depression is located anteriorly whilst the other is more prominent and is situated midway along the peristomial border. The AZM collar is not as prominent as in *E. eurystomus*, is straight to curved but never sigmoidal

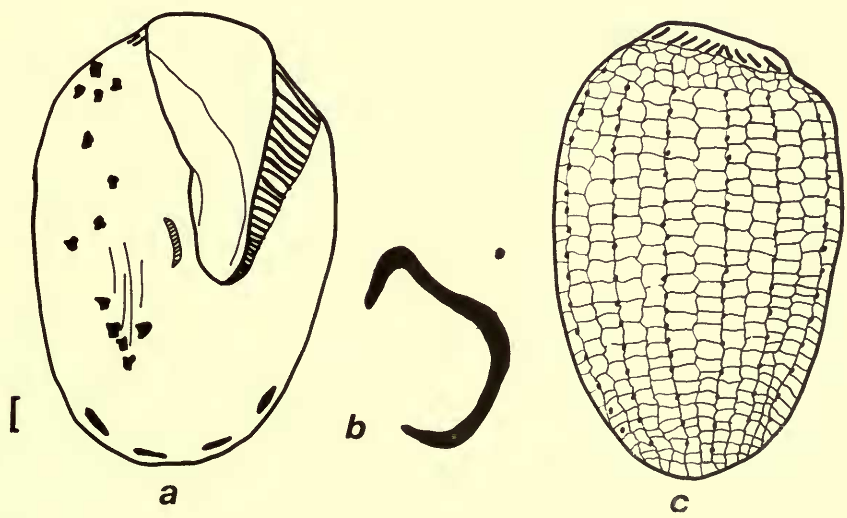

Fig. 9. *Euplotes aediculatus*. a. Ventral cirri. b. Nuclei. c. Dorsal argyrome. (After Pierson, Gierke & Fisher, 1968.)

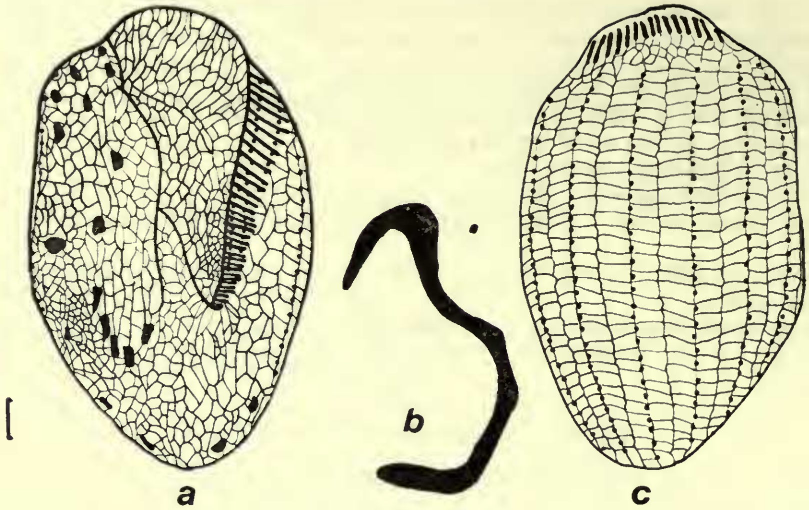

FIG. 10. *Euplotes aediculatus.* a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Tuffrau, 1960.)

and contains about 40 membranelles. The macronucleus is C-shaped with an arched or flattened back and the micronucleus is distinctly separate from the macronucleus.

The dorsal argyrome is of the double-eurystomus type and there are typically 8 dorsolateral kineties with about 20 cilia in the central kineties on the dorsal surface. There are 9 frontoventral, 5 transverse and 4 caudal cirri.

Euplotes affinis (Dujardin, 1841) Kahl, 1932

Until recently *E. affinis* and its variety with three caudal cirri, *E. affinis* forma *tricirratus* Kahl, 1932 had not been described using modern techniques. Curds (1974) redescribed a freshwater species which closely resembles the latter form and gave diagrams of the silver-line system. Tuffrau (1960) considered *E. affinis* to be a synonym of *E. charon* (Muller, 1773).

DIAGNOSIS. *Euplotes affinis* (Fig. 11) is a small (38 μm long, 26 μm wide) ovoid freshwater hypotrich with 9 frontoventral, 5 transverse and 3–4 caudal cirri. One of the caudal cirri is larger than the others and is held stiffly out to the right. The ventral surface is sculptured with 3 prominent ridges and the dorsal surface with 5 longitudinal ridges. The AZM has 18–20 membranelles and extends $\frac{2}{3}$ the length of the cell. There is a small undulating membrane. The dorsal argyrome is of the double-eurystomus type with 7 dorsolateral kineties and a maximum of 9 dorsal cilia in the central kineties. The macronucleus is a definite 3-shape and there is a small compact anterior micronucleus.

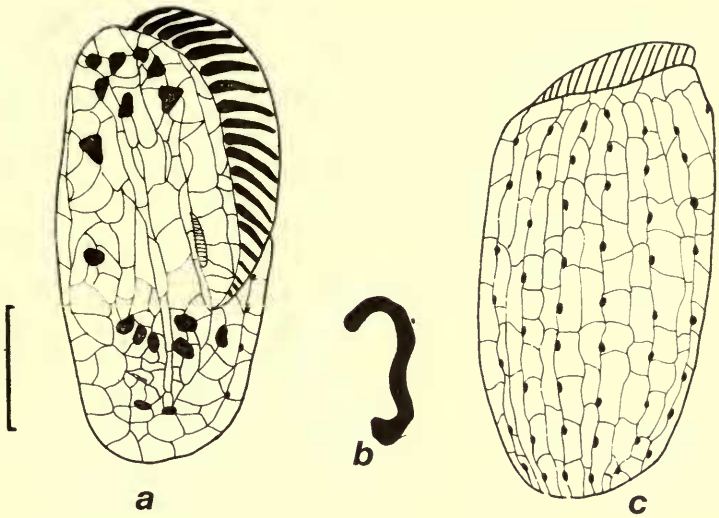

FIG. 11. *Euplotes affinis*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Curds, 1974.)

Euplotes alatus Kahl, 1932

The original description of this species was given by Kahl (1932) and new data concerning the silver-line system were added by Borror (1968a).

DIAGNOSIS. *Euplotes alatus* (Fig. 12) is a small (40 μm long, 30 μm wide) oval marine species. The dorsal surface has several inconspicuous low ridges but those on the ventral surface are far more conspicuous. The AZM extends just halfway down the length of the body and is composed of approximately 26 membranelles. The dorsal argyrome is of the double-eurystomus type with 8 dorsolateral kineties bearing 10–12 dorsal cilia in the central rows. There are 10 frontoventral, 5 transverse and 4–5 caudal cirri. The macronucleus is C-shaped which has an indentation in the left anterior edge which contains the small compact micronucleus.

Euplotes amieti Dragesco, 1970

This species is one of those described by Dragesco (1970) from the Cameroun in Africa. It has many similarities with *E. eurystomus* including the presence of a anterior peristomial pouch, a similar nucleus, a sigmoidal AZM which makes the present author doubt whether this is a true species or simply a geographical variety of *E. eurystomus*. However, because of the very large size, and more particularly the presence of 14 dorsolateral kineties, this organism has been treated here as a separate species until more information concerning *E. eurystomus* and *E. amieti* has been gathered.

DIAGNOSIS. *Euplotes amieti* (Figs. 13, 14) is one of the largest (140–240 μm long, 80–160 μm wide) species of *Euplotes* so far recorded. It is found in fresh waters

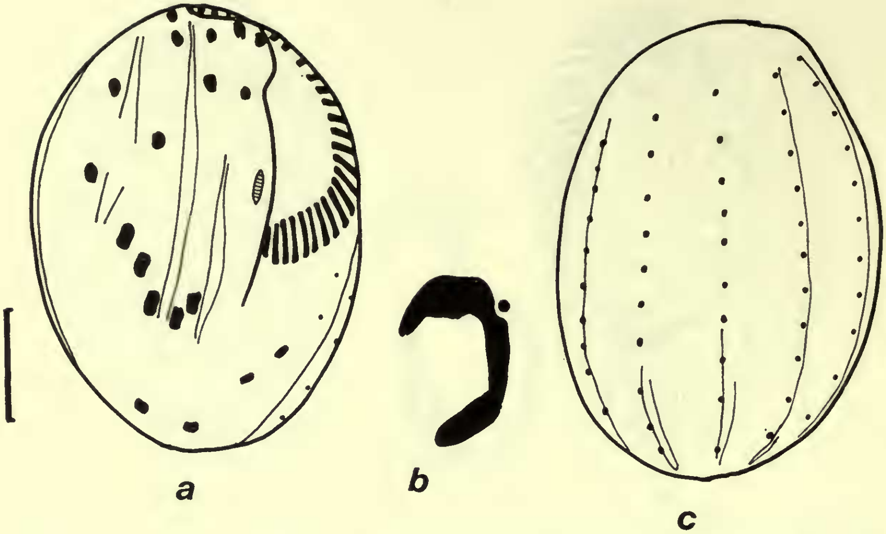

FIG. 12. *Euplotes alatus*. a. Ventral aspect. b. Nuclei. c. Dorsal aspect. (After Borror, 1968a.)

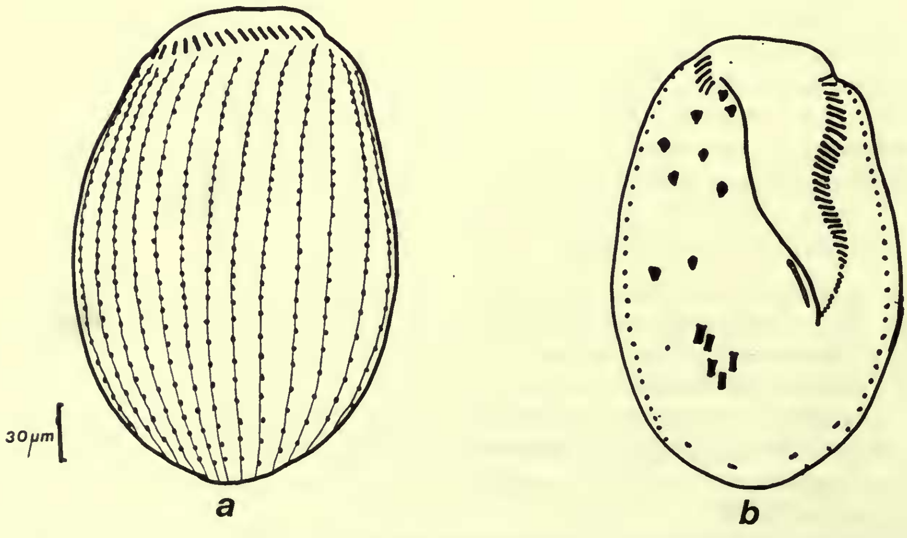

FIG. 13. *Euplotes amieti*. a. Dorsal aspect showing kineties. b. Ventral aspect. (After Dragesco, 1970.)

and has a characteristic shape ; the dorsal surface being highly convex while the ventral aspect is concave. The peristome is large, open and triangular in appearance. There is a well-developed peristomial collar and anterior pouch present. The AZM consists of 52–62 membranelles and winds sigmoidally down towards the cytostome. The dorsal argyrome is of the double-eurystomus type with 14 dorsolateral kineties bearing 28–30 cilia in the mid-dorsal rows. There are 9 frontoventral, 5 transverse and 4 caudal cirri. The macronucleus is an irregular 3-shape with a compact micronucleus situated in the left anterior corner of the macronucleus.

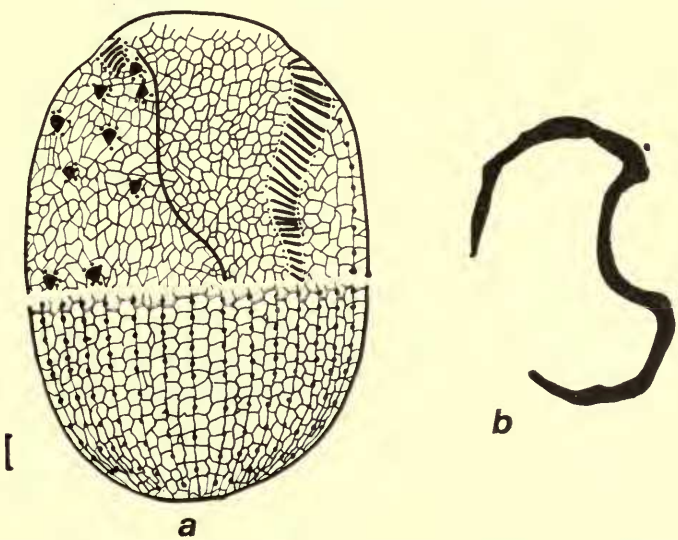

FIG. 14. *Euplotes amieti*. a. Ventral and dorsal argyromes. b. Nuclei. (After Dragesco, 1970.)

Euplotes antarcticus Fenchel and Lee, 1972

The description of this species depends solely upon the brief original report by Fenchel and Lee (1972) based on material collected in Antarctica.

DIAGNOSIS. *Euplotes antarcticus* (Fig. 15) is a medium-sized (85 μm long, 30 μm wide) marine species. The shape is unlike that of other species in being very elongate and almost rectangular in outline except for the pointed posterior region. The peristome is long and narrow and there is a cleft in the right peristomial margin. The AZM is composed of approximately 30 membranelles and extends down $\frac{2}{3}$ of the body to the cytostome. The dorsal surface is clearly sculptured with 6 longitudinal ridges. The dorsal argyrome was not drawn very clearly but appears to be of the double-eurystomus type with 8 kineties carrying about 13 cilia in the mid-dorsal rows. There are 10 frontoventral, 5 transverse and 4 or 5 caudal cirri. The macronucleus is an elongate 3-shape.

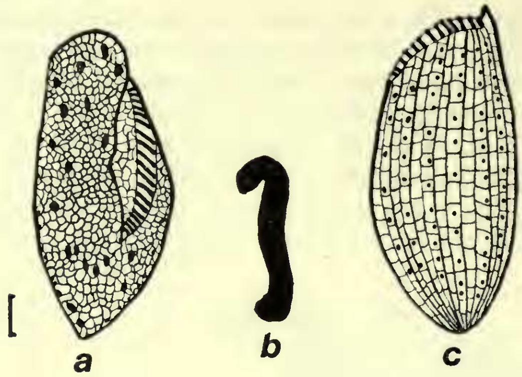

FIG. 15. *Euplotes antarcticus*. a. Ventral argyrome. b. Macronucleus. c. Dorsal argyrome. (After Fenchel & Lee, 1972.)

Euplotes balteatus (Dujardin, 1841) Kahl, 1932

This species was first described by Dujardin (1841) and although the descriptions given were brief and incomplete they were just sufficient to enable Kahl (1932) to identify the species and present better diagrams. The morphology of the silver-line systems were not available until Tuffrau (1964) published his work on polymorphism in the species. In the present author's opinion the *E. balteatus* described by Burkovsky (1970) is *E. charon*.

DIAGNOSIS. *Euplotes balteatus* (Fig. 16) is highly variable (30–150 μm long) in size and the actual size depends to a great extent upon its food source (Tuffrau, 1964). This species has been found living in marine waters but has also been frequently recorded in the intestinal tract of certain sea urchins (*Allocentrus fragilis*,

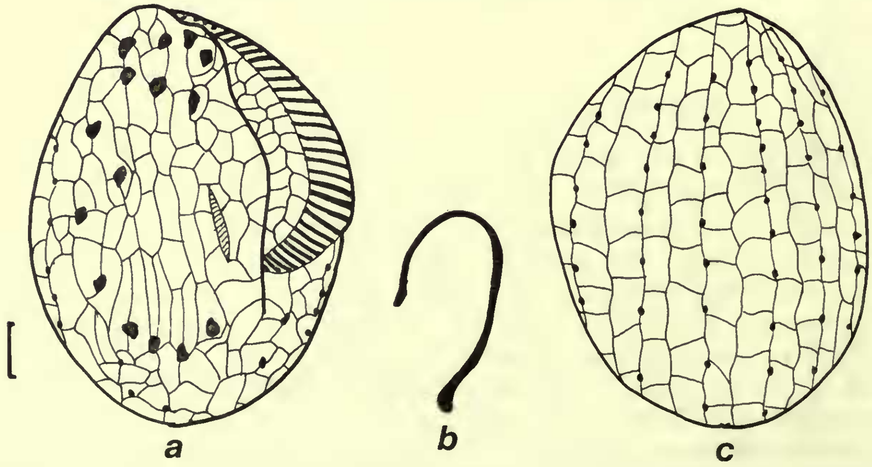

FIG. 16. *Euplotes balteatus*. a. Ventral argyrome. b. Macronucleus. c. Dorsal argyrome. (After Tuffrau, 1964.)

Strongylocentrotus droebachiensis, S. ehinoides, S. franciscanus and *S. purpuratus* – see Berger, 1965). The polymorphism of this organism is correlated with the AZM size which enlarges considerably when feeding upon ciliates such as *Philaster* sp. When feeding on bacteria there are 25–30 small membranelles but when feeding on other ciliates the membranelles are larger in size and there are then 70–80 in number. The dorsal argyrome is of the double-eurystomus type but is less regular than is usually found. Tuffrau (1964) reported that there are 8 dorsolateral kineties with up to 11 cilia in the mid-dorsal rows. There are 10 frontoventral, 5 transverse and 4 or 5 caudal cirri. The macronucleus is an open C-shape when feeding upon bacteria but more horse-shoe shaped when feeding on ciliates.

Euplotes bisulcatus Kahl, 1932

This species has been reported from marine sponges by Wenzel (1961) since its first description by Kahl (1932). Since that time Borror (1963) isolated it from algal growths in tidal marsh ponds and described its silver-line system.

DIAGNOSIS. *Euplotes bisulcatus* (Fig. 17) is a small (40 μm long, 30 μm wide) oval marine hypotrich. The dorsal surface has prominent double-edged ridges separated by shallow grooves parallel to the dorsal ciliary rows 4, 5 and 6. The ventral surface is also ridged and the central ridge is very conspicuous. The AZM extends almost ⅔ down the length of the cell and is composed of about 17 membranelles. The dorsal argyrome is of the double-eurystomus type with 8 dorsolateral kineties bearing 5–7 cilia in the mid-dorsal rows. There are 9 frontoventrals, 5 transverse and 3 caudal cirri. The macronucleus is C-shaped with an adjacent anterior micronucleus.

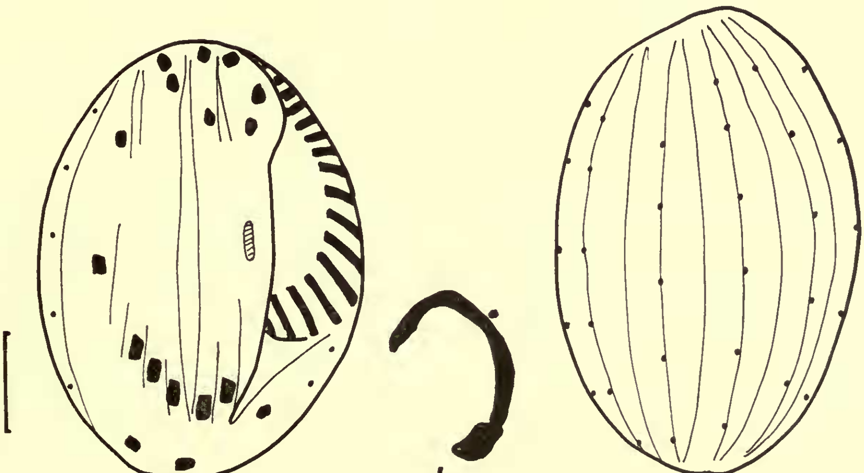
a b c

FIG. 17. *Euplotes bisulcatus*. a. Ventral aspect. b. Nuclei. c. Dorsal aspect. (After Borror, 1963.)

Euplotes charon (Müller, 1786) Ehrenberg, 1830

This species has a long history and was described successively by Müller (1786), Ehrenberg (1830, 1833, 1838), Dujardin (1841) and Stein (1859). These descriptions vary considerably and it was not until almost a century later that Kahl (1932) gave a good succinct description of this species. Later Tuffrau (1960) and Borror (1963) were to describe the silver-line system. Tuffrau (1960) was of the opinion that *E. affinis* and *E. moebiusi* were synonyms of *E. charon* but recently Curds (1974) has demonstrated that these former two organisms are species in their own right.

DIAGNOSIS. *Euplotes charon* (Fig. 18) is a medium (70–96 μm long) oval marine species which has a very large open triangular peristomial region. The right margin

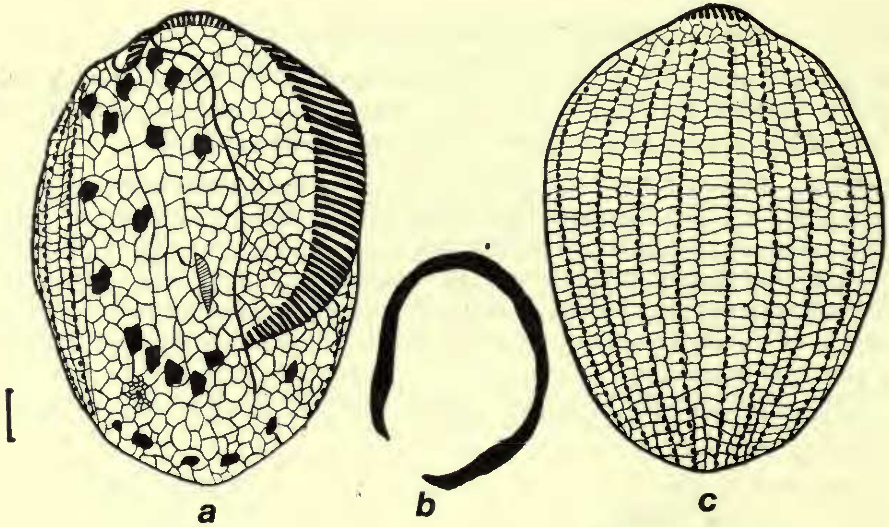

FIG. 18. *Euplotes charon.* a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Tuffrau, 1960.)

of the peristome winds sinusoidally down past the cytostome to about $\frac{7}{8}$ of the body length. The AZM bears approximately 70 strong membranelles while the AZM as a whole extends down to about $\frac{2}{3}$ of the body length. The dorsal argyrome is of the double-eurystomus type with 12 dorsolateral kineties carrying 35–40 dorsal cilia in the mid-dorsal rows according to Tuffrau (1960) but only 18–21 according to Borror (1963). There are 10 frontoventrals, 5 transverse and 5–8 caudal cirri. The macronucleus is horseshoe shaped and there is a small compact micronucleus situated anteriorly.

Euplotes crenosus Tuffrau, 1960

This species was first discovered and described by Tuffrau (1960) and has remained unmentioned since that time.

DIAGNOSIS. *Euplotes crenosus* (Fig. 19) is a small (50–70 μm long) freshwater oval hypotrich. There is a prominent notch at the anterior end of the cell which is coincident with a longitudinal depression on the ventral surface of the cell. The peristome is quite small and extends just over halfway down the body length. There are 25–30 membranelles in the adoral zone. The dorsal argyrome is of the double-eurystomus type with 8 dorsolateral kineties bearing up to about 23 cilia in the mid-dorsal rows. There are 10 frontoventral, 5 transverse and 4 caudal cirri. The macronucleus is C-shaped with the micronucleus situated half-way down the left border of the macronucleus.

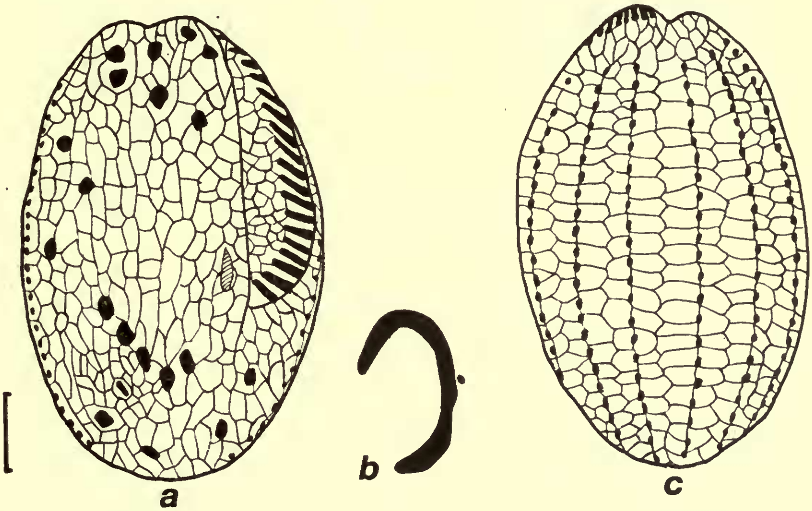

FIG. 19. *Euplotes crenosus*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Tuffrau, 1960.)

Euplotes dogieli Agamaliev, 1967

This species has only been described once and that was from material found in sand samples taken from the Caspian Sea.

DIAGNOSIS. *Euplotes dogieli* (Fig. 20) is a small (60 μm long) marine species whose shape closely resembles that of *E. poljanskyi* Agamaliev, 1966 which is ellipsoid. The peristome is of medium size and it stretches about ⅔ of the length of the cell. There is a definite curved indentation almost midway down the left peristomial margin. The AZM is composed of 35–38 membranelles and is rather narrow. The dorsal argyrome is of the double-eurystomus type with 7 dorsolateral kineties carrying about 13 cilia in the mid-dorsal rows. There are 9 frontoventral, 5 transverse and 3 caudal cirri. The macronucleus is C-shaped with the anterior curve being angular and acute. The compact micronucleus is situated to the left of this anterior angular bend.

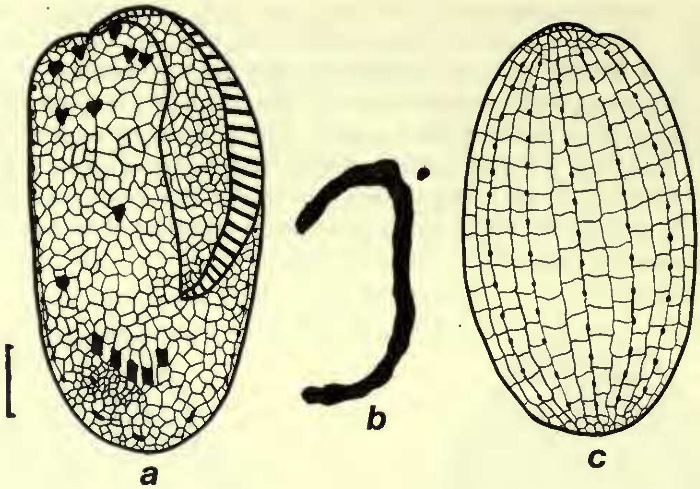

FIG. 20. *Euplotes dogieli*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Agamaliev, 1967.)

Euplotes eurystomus (Wrzesniowski, 1870) Kahl, 1932

Difficulties over the identification of *E. eurystomus* and confusion of it with several other species is well documented but unfortunately is still perpetuated. Wrzesniowski (1870) originally described an organism which he named *E. patella* var. *eurystomus* Wrzesniowski, 1870 which was later elevated to the species level *E. eurystomus* (Wrzesniowski, 1870) Kahl, 1932. Pierson (1943) made a comparative study of several strains of *Euplotes* and four distinct species were described by him. One of these was *E. eurystomus* and one was a hitherto undescribed organism that was named *E. aediculatus* Pierson, 1943. It was not until Tuffrau (1960) introduced silver impregnation methods to *Euplotes* taxonomy that *E. patella* could readily be distinguished from *E. eurystomus* and *E. aediculatus*; unfortunately Tuffrau (1960) also introduced a considerable amount of confusion since he described *E. aediculatus* but called it *E. eurystomus* and described *E. eurystomus* but called it *E. plumipes* Stokes, 1884. Even though Pierson, Gierke and Fisher (1968) pointed out the errors of Tuffrau (1960), Carter (1972) disregarded the evidence and followed the scheme of Tuffrau (1960). Thus Carter (1972) also described *E. aediculatus* under the name of *E. eurystomus* and *E. eurystomus* under the name *E. plumipes*; furthermore, this latter author reintroduced the species *E. variabilis* Stokes, 1887 which in the opinion of the present author is a variant of *E. eurystomus*.

It is evident from the original diagrams given by Wrzesniowski (1870) (see Fig. 21b) that the shape of the AZM is definitely sigmoidal and Kahl (1932) placed particular emphasis upon this shape as being a distinctive and immediately visible feature. A comparison of the original diagrams in Figs. 21a and 21b of *E. plumipes* drawn by Stokes (1884) and *E. patella* var. *eurystomus* drawn by Wrzesniowski (1870) shows that both have a sigmoidal AZM and in fact have long been regarded as synonymous species (Kahl, 1932; Borror, 1972). The sigmoidal shape of the AZM is also obvious in the silver preparations of *E. plumipes* and *E. variabilis* (Fig. 22) drawn by Carter (1972). In the descriptions that follow *E. eurystomus* (Figs. 23, 24) is regarded as was originally intended by Wrzesniowski (1870) and Kahl (1932), not as by Tuffrau (1960) and Carter (1972).

DIAGNOSIS. *Euplotes eurystomus* (Figs. 22, 23, 24) is a large (100–160 μm long, 40–90 μm wide) ovoid freshwater hypotrich. The buccal overture is triangular

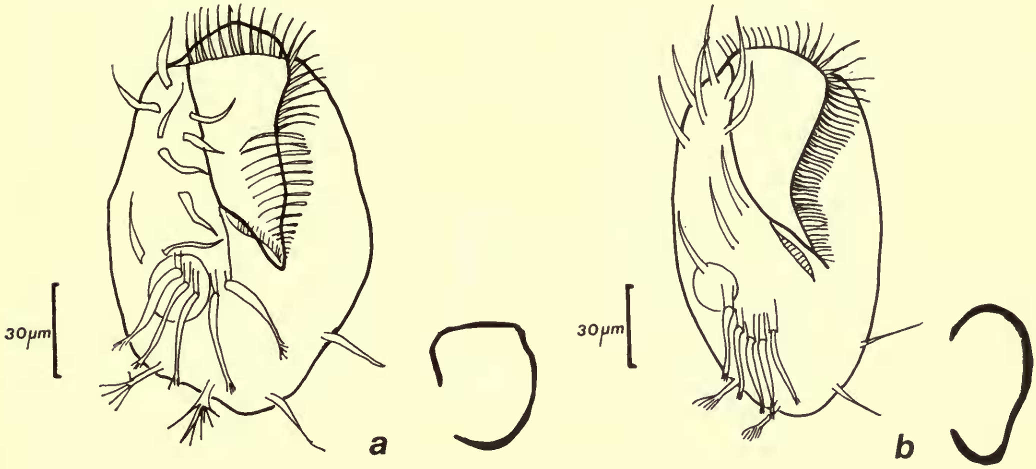

FIG. 21. Species synonymous with *Euplotes eurystomus*. a. Ventral aspect and macronucleus of *Euplotes plumipes*. (After Stokes, 1884.) b. Ventral aspect and macronucleus of *Euplotes patella* var. *eurystomus*. (After Wrzesniowski, 1870.)

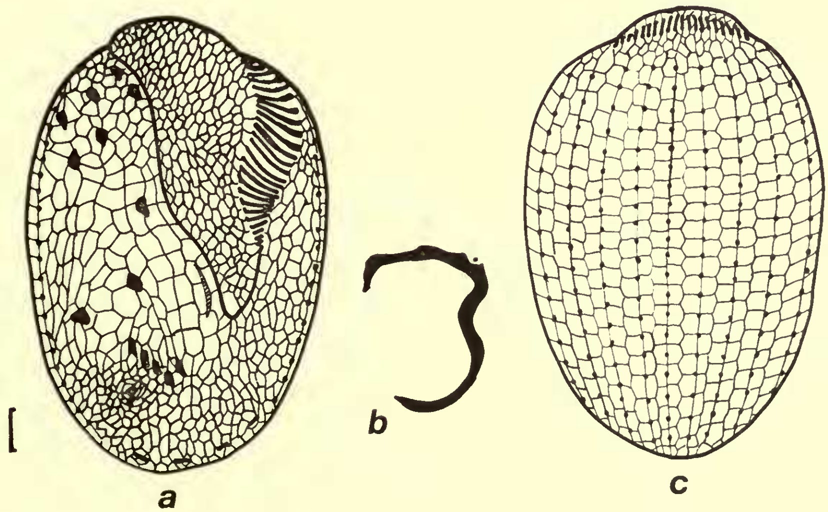

FIG. 22. *Euplotes variabilis*, a species synonymous with *Euplotes eurystomus*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Carter, 1972.)

and there is a single anterior peristomial pouch. The AZM collar is high and prominent. The AZM is markedly sigmoid in shape and contains 50–65 membranelles. There are 9 frontoventral, 5 transverse and commonly 4 caudal cirri although Carter (1972) found 5 caudals in one specimen. The arrangement of cirri is shown in Figs. 22, 23 and 24. The dorsal argyrome is typical of the double-eurystomus type with 10 dorsolateral kineties although Carter (1972) reported two strains that had a

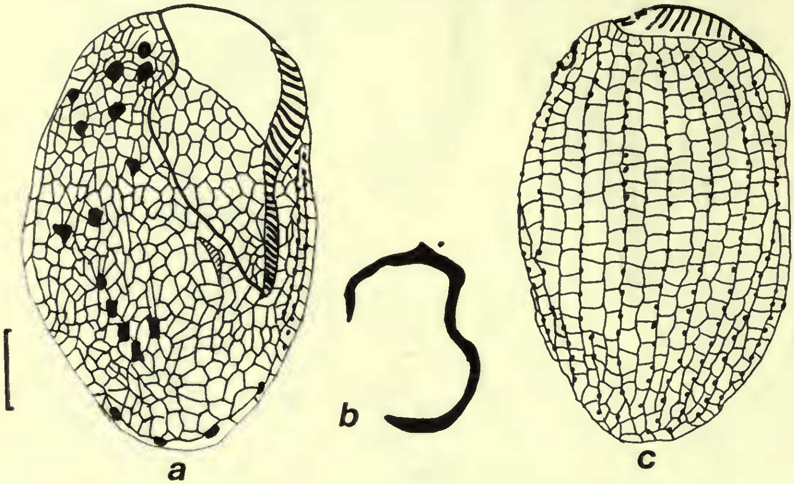

FIG. 23. *Euplotes eurystomus*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Pierson, Gierke & Fisher, 1968.)

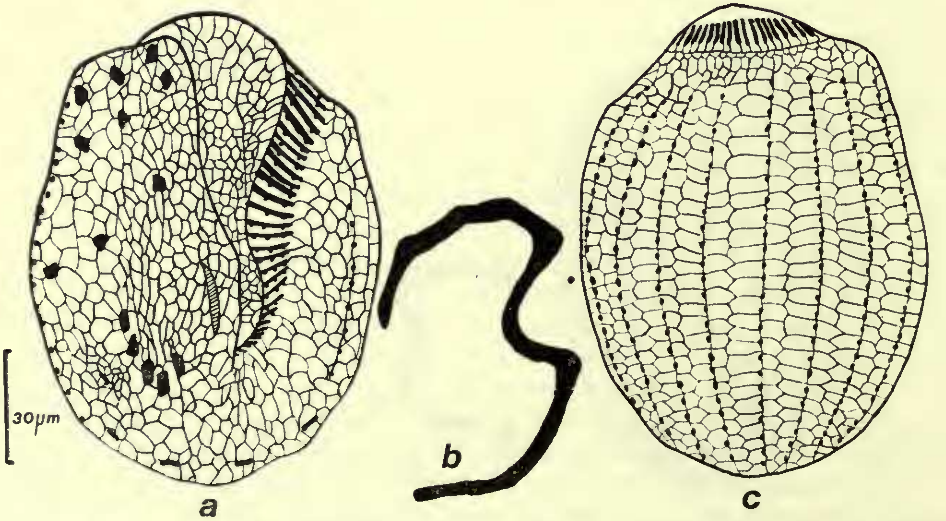

FIG. 24. *Euplotes eurystomus*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (Called *Euplotes aediculatus* in Tuffrau, 1960.)

variable number (8–12) of kineties. The dorsal and ventral silver-line systems are shown in Figs. 22, 23 and 24. There are 17–25 dorsal cilia in the central kineties.

The macronucleus is typically 3-shaped and there is sometimes a definite concave notch which contains the micronucleus. Carter (1972) believed that the nuclear pattern, the sigmoidal AZM, the possession of an anterior peristomial pouch and a wide variation in the numbers of dorsolateral kineties were sufficient to distinguish two strains of *Euplotes* from *E. eurystomus* and proposed the restoration of the species *E. variabilis* Stokes, 1884. However, a similar nuclear pattern was observed by Pierson (1943) in *E. eurystomus*; the sigmoidal AZM has already been stated to be a characteristic feature of *E. eurystomus* which species also has an anterior peristomial pouch. In the present author's opinion the variability of the numbers of dorsolateral kineties is not in itself sufficient to distinguish *E. variabilis* Stokes from *E. eurystomus*.

Euplotes harpa Stein, 1859

This species was first properly described by Stein (1859) although Dujardin (1841) seems to have been the first to see this organism which he called *Ploesconia cithara*. Wallengren (1900, 1901) gave the first good diagram of *E. harpa* and these conform well with the descriptions of Stein (1859). Although Chatton made silver preparations of this species in 1939 these were not published until Tuffrau (1960) did so with new specimens collected in 1955.

DIAGNOSIS. *Euplotes harpa* (Fig. 25) is a large (150–160 μm long) marine species with a more or less oval shape, although the left side is always more curved than the other. The peristome is large and open and there is a conspicuous lip on the right margin. The AZM is very curved and extends about ⅘ down the length of the body. There are approximately 65–70 membranelles in the AZM. The dorsal argyrome is of the double-eurystomus type with 13 dorsolateral kineties bearing 40–45 dorsal cilia in the central rows. There are 10 frontoventral, 5 transverse and 4 caudal cirri. The macronucleus is an open C-shape with tendencies towards a 3-shape. The micronucleus is in an anterior position.

Euplotes inkystans Chatton in Tuffrau, 1960

Although this species was discovered by Chatton in the 1950's it was not described by him but preparations that he made were described by Tuffrau (1960).

DIAGNOSIS. *Euplotes inkystans* (Fig. 26) is a medium (70–80 μm long) freshwater oval species. There is a prominent notch on the right of the peristomial collar which is narrow but rounded. The peristome is long and extends almost ¾ down the length of the cell. The AZM is composed of approximately 40 membranelles. The dorsal argyrome is of the double-eurystomus type and there are 10 dorsolateral kineties with about 25 dorsal cilia in the central rows. There are 10 frontoventral, 5 transverse and 4 (or rarely 5) caudal cirri. The macronucleus is a simple open C-shape with the micronucleus lying on the left border.

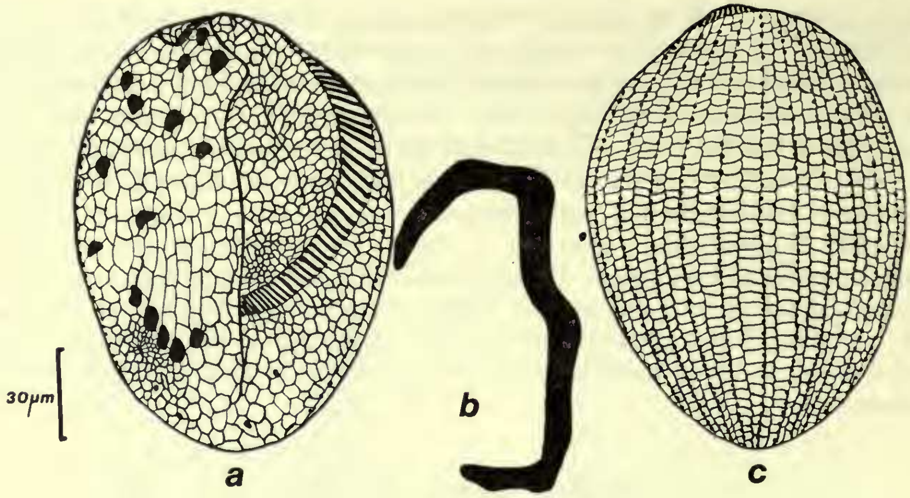

FIG. 25. *Euplotes harpa*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Tuffrau, 1960.)

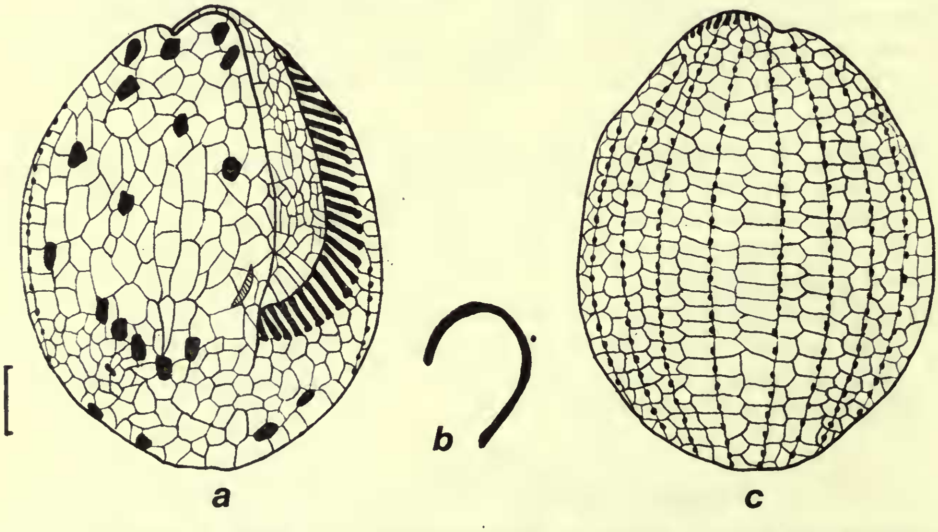

FIG. 26. *Euplotes inkystans*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Tuffrau, 1960.)

Euplotes latus (Agamaliev, 1967)

Euplotes latus was described by Agamaliev (1967) under the name *E. patella* forma *latus* Kahl, 1932. However, it is evident from the silver-line system that this species cannot be a form of *E. patella* for several reasons (compare Figs. 27 and 40); for example *E. latus* has a double-eurystomus type of dorsal argyrome whereas *E. patella* has a double-patella type, the numbers of kineties and dorsal cilia are different and the shapes of the macronuclei are different. However, it is also clear that the organism described by Agamaliev (1967) does not conform to any others described to date and the present author considers it sufficiently different to warrant elevating it to a species in its own right.

DIAGNOSIS. *Euplotes latus* (Fig. 27) is a medium (70 μm long) marine species that is broadly rounded posteriorly but narrows anteriorly. The peristome is large and extends just over ⅔ down the length of the cell. The AZM is broadly curved and is composed of 35–40 membranelles. The dorsal argyrome is of the double-eurystomus type with only 6 dorsolateral kineties bearing up to 15 dorsal cilia in the central rows. There are 9 frontoventral, 5 transverse and 4 caudal cirri. The two centrally positioned frontoventral cirri (V_2 and VI_2) are situated very close together. The macronucleus is an open angular C-shape with a micronucleus situated close to the left anterior border.

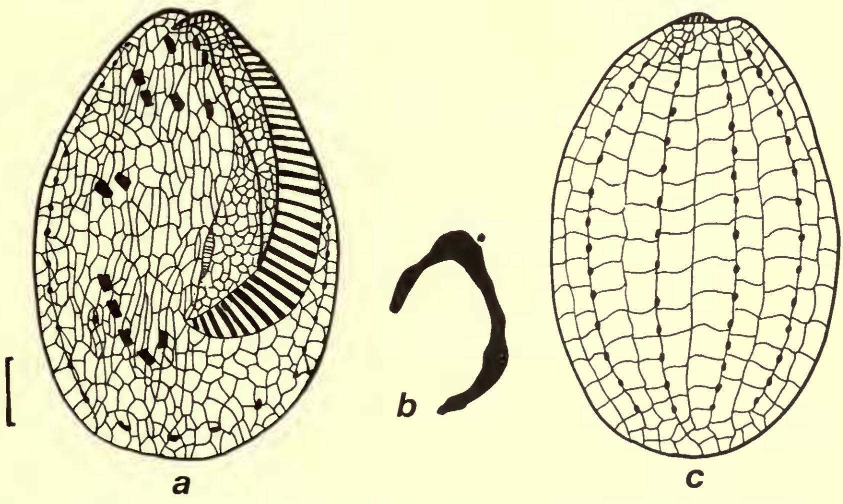

FIG. 27. *Euplotes latus*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (Called *Euplotes patella* forma *latus* in Agamaliev, 1967.)

Euplotes magnicirratus Carter, 1972

This species is one of the four new species described recently by Carter (1972).

DIAGNOSIS. *Euplotes magnicirratus* (Fig. 28) is a small (54 μm long, 40 μm wide) oval marine species. The peristomial cavity is rather wide and extends approximately ¾ of the length of the cell. The AZM is composed of about 50 membranelles and is relatively straight for the majority of its length and then sharply curves in towards the cytostome. The dorsal surface is convex and prominently ridged. The dorsal argyrome is of the double-eurystomus type but the polygons are rather more square than is usual. There are 8 dorsolateral kineties each containing 13–17 dorsal cilia except the left lateral one which is short and contains only 5–8 cilia. The transverse cirri are particularly large and there are 10 frontoventrals, 5 transverse and 4 caudal

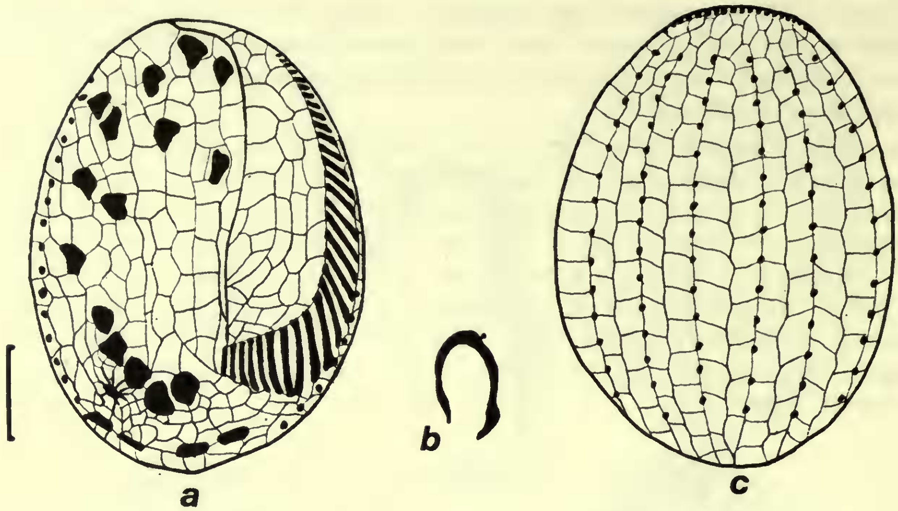

FIG. 28. *Euplotes magnicirratus*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Carter, 1972.)

cirri. The macronucleus is an irregular hoop-shape and is highly characteristic of the species, since both ends are pointed. The micronucleus is situated in a small depression in the upper left border of the macronucleus.

Euplotes neapolitanus Wichterman, 1964

This species was first described briefly by Wichterman (1962a, b) and later (1964) more precisely from material collected from 50–60 metres in the proximity of the Bay of Naples.

DIAGNOSIS. *Euplotes neapolitanus* (Fig. 29) is a large (130 μm long, 70 μm wide) marine species that is ellipsoidal in shape although the anterior is often wider and more truncated than the posterior. The peristome is conspicuous and extends approximately $\frac{4}{5}$ down the body length. The AZM is composed of about 65 membranelles. The dorsal argyrome is of the double-eurystomus type consisting of 11 dorsolateral kineties with about 18 cilia in the mid-dorsal rows. There are 10 fronto-ventral, 5 transverse and 4 caudal cirri. The macronucleus is C-shaped but both arms point posteriorly and the small spherical micronucleus lies in the middle of the body on the left of the macronucleus.

Euplotes octocirratus Agamaliev, 1967

Agamaliev (1967) described this species from samples of sand collected from the Caspian Sea.

DIAGNOSIS. *Euplotes octocirratus* (Fig. 30) is a small (55–60 μm long) marine hypotrich that is more or less oval in outline although the posterior is rather narrower than the anterior. The peristome is quite large and extends ⅔ down the length of the cell. The AZM is regularly curved and is composed of about 30 membranelles. The dorsal argyrome is of the double-eurystomus type with 7 dorsolateral kineties carrying up to 14 cilia in the mid-dorsal rows. There are 10 frontoventral, 5 transverse and 3 caudal cirri. The macronucleus is an angular C-shape with a compact micronucleus in an anterior position.

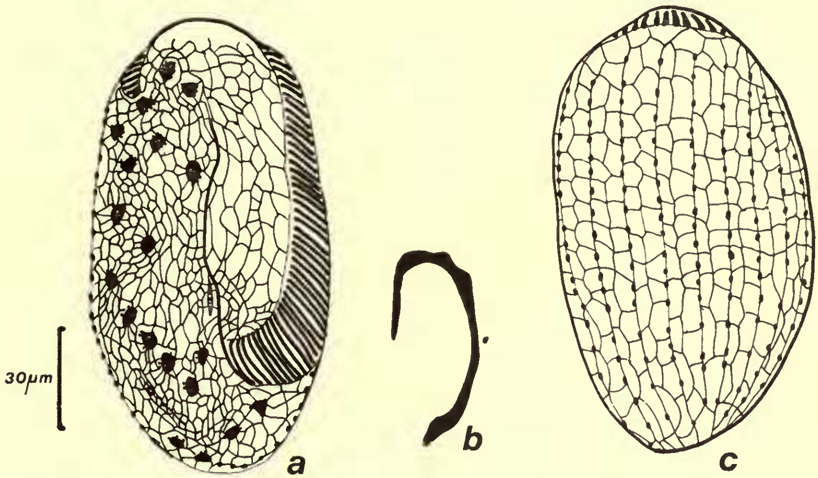

FIG. 29. *Euplotes neapolitanus.* a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Wichterman, 1964.)

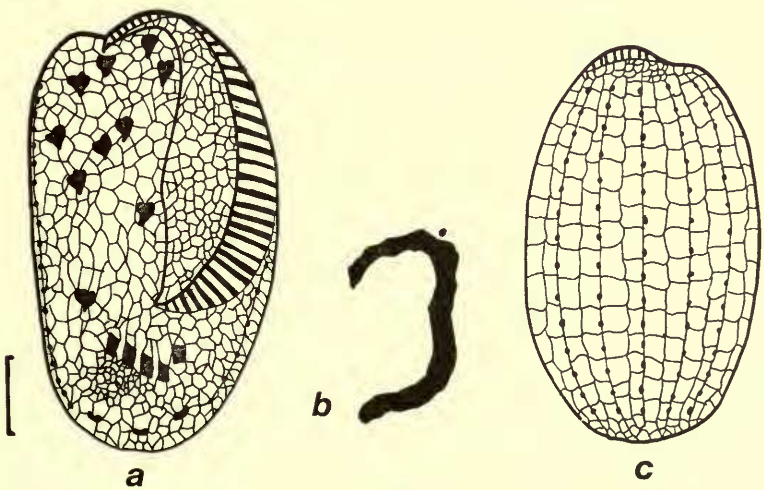

FIG. 30. *Euplotes octocirratus.* a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Agamaliev, 1967.)

Euplotes parkei Curds, 1974

This species is a recent addition to the genus.

DIAGNOSIS. *Euplotes parkei* (Fig. 31) is a small (40 μm long, 30 μm wide) euryhaline species that is broadly oval in outline. The dorsal surface has 6 inconspicuous low longitudinal ridges and the ventral surface has 7 minor ridges. The AZM is about ⅔ of the body length and composed of 18 membranelles. A deep pocket near the cytostome contains an undulating membrane. There are usually 8 but occasionally 9 frontoventral, 5 transverse and 4 caudal cirri. The dorsal argyrome is of the double-eurystomus type with 8 dorsolateral kineties bearing a maximum of 11 cilia in the mid-dorsal rows. The ventral argyrome consists of a series of few but large polygons and resembles that of *E. cristatus* (see Tuffrau, 1960). The macronucleus is C-shaped and the micronucleus is situated close to its left anterior edge.

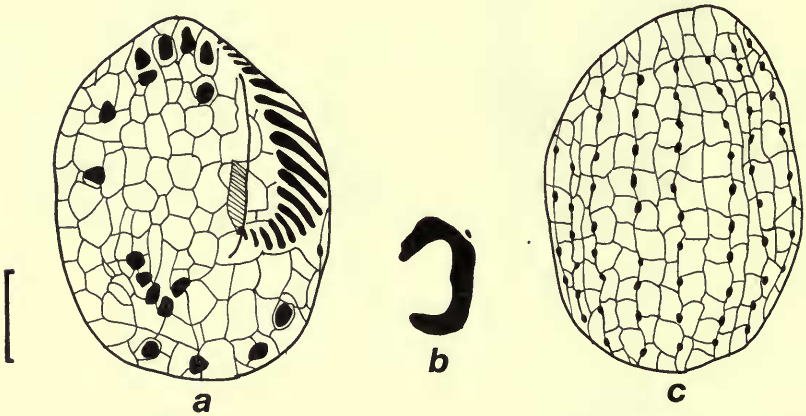

FIG. 31. *Euplotes parkei*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Curds, 1974.)

Euplotes poljanskyi Agamaliev, 1966

This species has been described on two occasions by Agamaliev (1966, 1967) from samples of sand collected from the Caspian Sea.

DIAGNOSIS. *Euplotes poljanskyi* (Fig. 32) is a small to medium-sized (55–70 μm long) marine ciliate. It has an elongated ellipsoidal shape with a medium-sized peristome that is strongly concave on the right margin. The narrow AZM is composed of 36–40 membranelles, and it extends down to about ⅔ the body length. The dorsal argyrome is of the double-eurystomus type with 7 dorsolateral kineties bearing 10–12 dorsal cilia in the central rows. There are 8 frontoventral, 5 transverse and 3 caudal cirri. The macronucleus is C-shaped and both ends are bluntly narrower than the central regions. The micronucleus lies in an anterior position.

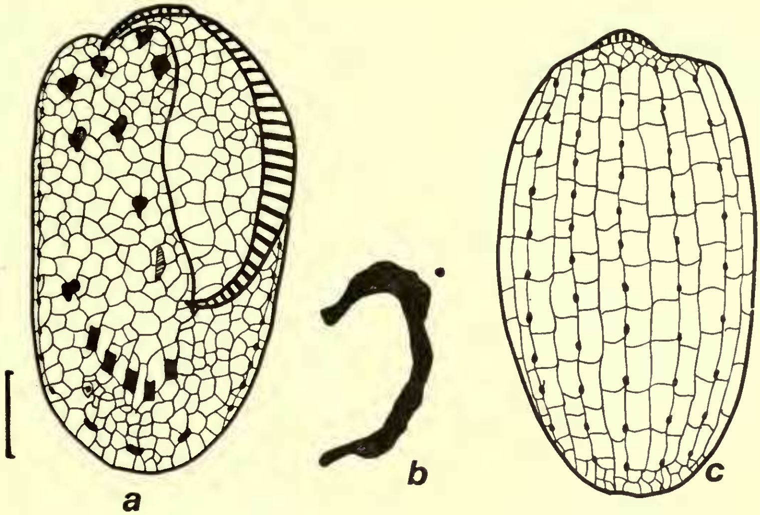

FIG. 32. *Euplotes poljanskyi*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Agamaliev, 1966.)

Euplotes polycarinatus Carter, 1972

Recognition of this species relies upon the recent description of Carter (1972).

DIAGNOSIS. *Euplotes polycarinatus* (Fig. 33) is a medium (90 μm long, 80 μm wide) almost triangular shaped marine hypotrich. The shape of the AZM is one of its most distinctive features as it is very wide and crescent-like with 60–76 membranelles. The dorsal surface is slightly ridged and the dorsal argyrome is of the double-eurystomus type with 20 narrowly spaced dorsolateral kineties bearing up to 23 dorsal cilia. A few specimens have been seen with 21 dorsolateral kineties. The ventral surface is flat and there are 10 frontoventral, 5 transverse and 5–9 caudal cirri. The macronucleus is a highly irregular 3-shape with a deep involution on the upper right border within which the compact micronucleus lies.

Euplotes quinquecarinatus Gelei, 1950

The general morphology of this species was first briefly described by Gelei (1950) and the silver-line system was added later by Borror (1968a).

DIAGNOSIS. *Euplotes quinquecarinatus* (Fig. 34) is a small (55 μm long, 40 μm wide) marine species whose general outline shape tends to be oval although there may be conspicuous wing-like extensions to the ridges associated with dorsal cilium rows 1, 3 and 7. The AZM is small and extends halfway down the body length and contains 25–30 membranelles. The dorsal argyrome is of the double-eurystomus type with 9 dorsolateral kineties carrying 13–15 cilia in the mid-dorsal rows. There are 9 frontoventral, 5 transverse and 4 caudal cirri. The macronucleus is C-shaped and the micronucleus lies in an anterior position.

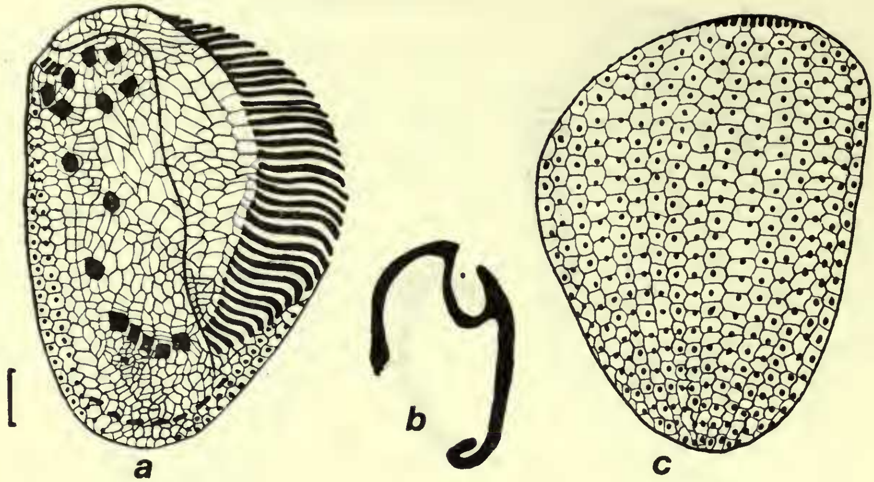

FIG. 33. *Euplotes polycarinatus.* a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Carter, 1972.)

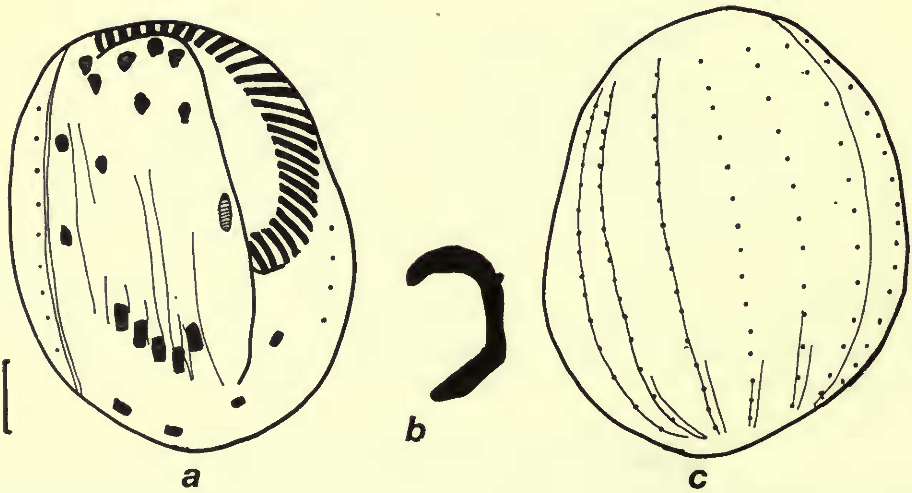

FIG. 34. *Euplotes quinquecarinatus.* a. Ventral aspect. b. Nuclei. c. Dorsal aspect. (After Borror, 1968a.)

Euplotes trisulcatus Kahl, 1932

Kahl (1932) originally found this species in marine aquariums and gave sufficiently precise diagrams and descriptions to enable Tuffrau (1960), Borror (1963) and Carter (1972) to identify this species in other marine samples. The descriptions of the silver-line system of this species given both by Tuffrau (1960) and Carter (1972) are identical.

Diagnosis. *Euplotes trisulcatus* (Fig. 35) is a small (40 μm long, 30 μm wide) form that has been only recorded in marine habitats. The shape of the body is distinctive in that it is prominently narrower at its posterior end. There is a pronounced extension of the right side of the body beyond the peristomial collar. The peritomial cavity is long and narrow extending about $\frac{2}{3}$ down the body. The AZM is evenly curved along the outer border of the peristome and contains 25–36 membranelles. The dorsal surface is deeply ridged showing three prominent furrows. The dorsal argyrome is of the double-eurystomus type and there are 7 dorsolateral kineties with a maximum of 11 dorsal cilia widely separated in the central rows. There are 10 frontoventral, 5 transverse and 4 caudal cirri although Borror (1963) reported the presence of only 3 caudals. The macronucleus is a very open C-shape with angular rather than rounded ends. The micronucleus is compact and is situated anteriorly near the upper left border of the macronucleus.

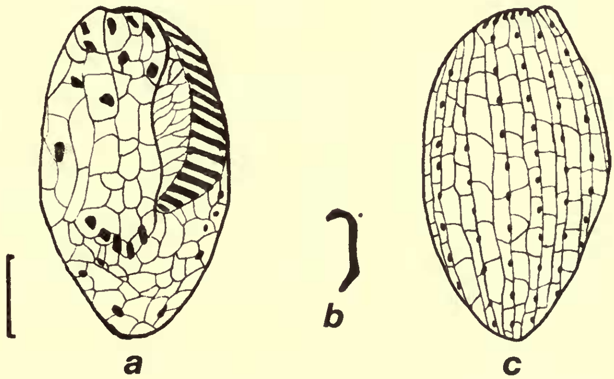

Fig. 35. *Euplotes trisulcatus.* a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Tuffrau, 1960.)

Euplotes tuffraui Berger, 1965

Euplotes tuffraui was described by Berger (1965) from samples taken from the posterior digestive tract of three species of sea urchins.

Diagnosis. *Euplotes tuffraui* (Fig. 36) is a large (113 μm long, 73 μm wide) marine species that is found in the digestive tract of strongylocentrotid echinoids. The three urchins that have to date been reported to contain this species are *Allocentrotus fragilis, Strongylocentrotus echinoides* and *S. purpuratus.* The shape of the body is narrowly pyriform with the anterior end often being distinctly pointed. The AZM is just over half the length of the body and is composed of 40–45 membranelles. The dorsal surface is sculptured longitudinally with 7 ridges. The dorsal argyrome is of the double-eurystomus type but irregular with 10 (rarely 9) dorsolateral kineties with 8–11 dorsal cilia per kinety. There are 8–10 frontoventral cirri depending upon the degree of fusion of the infraciliary bases in rows III and IV. There are 5 transverse and 4 caudal cirri. The macronucleus is C-shaped with a compact anterior micronucleus.

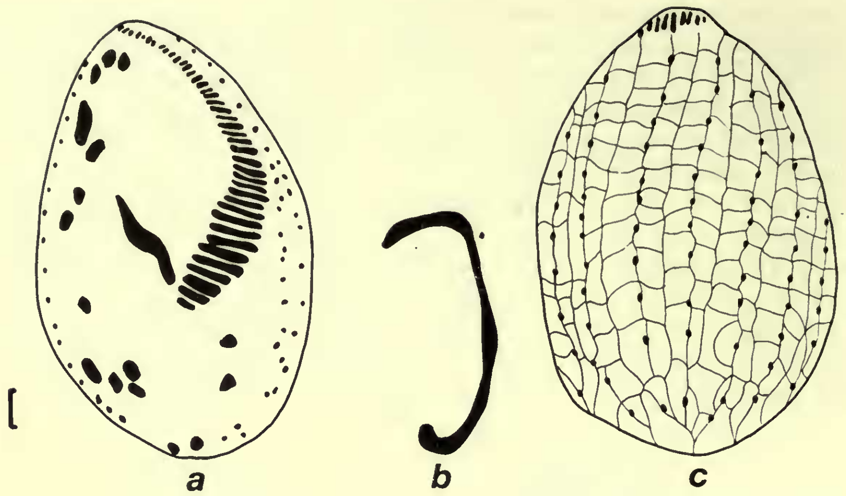

FIG. 36. *Euplotes tuffraui*. a. Ventral aspect. b. Nuclei. c. Dorsal argyrome. (After Berger, 1965.)

SECTION C. KEY TO SPECIES WITH A DOUBLE-PATELLA TYPE DORSAL ARGYROME

36 a Double dorsal argyrome with large polygons on right and small polygons on left of kineties **37**
b Double dorsal argyrome with large polygons on left and small polygons on right of kineties **38**
37 a 9 frontoventral and 5 transverse cirri . . . . *E. zenkewitchi*
b 8 frontoventral and 6 transverse cirri . . . . *E. strelkovi*
38 a 7 or less dorsolateral kineties, 7, 8 or 10 frontoventral cirri **39**
b 8 or more dorsolateral kineties, 9 frontoventral cirri **40**
39 a 10 frontoventral cirri, 6 or less dorsal cilia in central kineties . . . *E. variseta*
b 7 or 8 frontoventral cirri, 11–15 dorsal cilia in central kineties . . . *E. raikovi*
40 a 8 dorsolateral kineties . . . . *E. octocarinatus*
b 9 dorsolateral kineties **41**
41 a With symbiotic green algae and about 60 membranelles in AZM . *E. diadaleos*
b Usually without symbionts, 30–35 membranelles in AZM **42**
42 a 11–15 dorsal cilia in central kineties . . . . *E. apsheronicus*
b 25–30 dorsal cilia in central kineties . . . . *E. patella*

SECTION C. DESCRIPTIONS OF SPECIES

Euplotes apsheronicus Agamaliev, 1966

This organism was originally described by Agamaliev (1966) from specimens collected from sand samples from the Caspian Sea. A year later the same author redescribed the species (Agamaliev, 1967) with a few amendments to the original description.

DIAGNOSIS. *Euplotes apsheronicus* (Fig. 37) is a small (50–60 μm long) marine species that is ellipsoid in shape. There is a distinct peristomial collar and the peristome is of medium size being just over half the body length. The AZM is composed of 30–35 membranelles. The dorsal argyrome is of the double-patella type with 9 dorsolateral kineties (not 7–8 as originally given by Agamaliev, 1966) and these bear about 15 cilia in the mid-dorsal rows. There are 9 frontoventral, 5 transverse and 4 caudal cirri. The macronucleus is an angular and very open C-shape with a micronucleus located anteriorly.

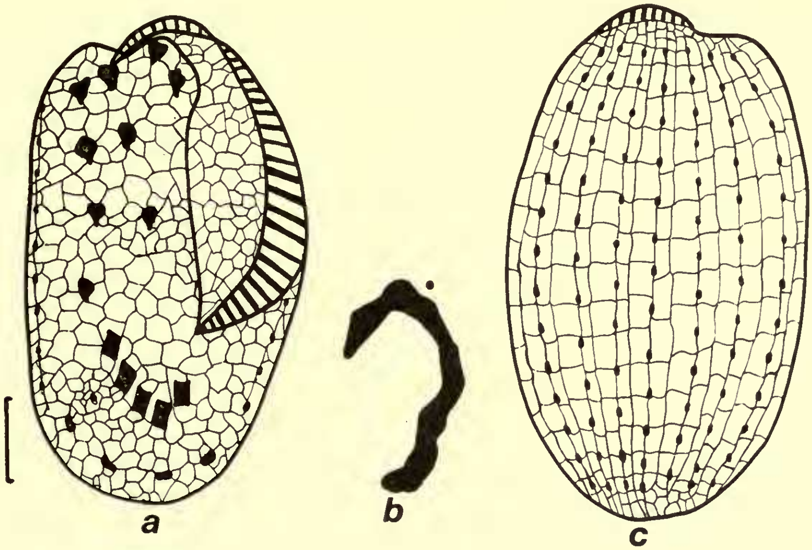

FIG. 37. *Euplotes apsheronicus*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Agamaliev, 1966.)

Euplotes diadaleos Diller and Kounaris, 1966

This species has been recorded on one occasion only when Diller and Kounaris (1966) isolated it from an artificial pond in Pennsylvania, U.S.A.

DIAGNOSIS. *Euplotes diadaleos* (Fig. 38) is a medium (92 μm long, 57 μm wide) freshwater species that contains symbiotic zoochlorellae. The body is generally flattened and oval in outline. The peristome extends slightly beyond the midline of the body. The AZM consists of about 40–45 membranelles that curve smoothly to the cytostome. The dorsal argyrome is of the double-patella type with 9 dorsolateral kineties containing 15–20 cilia in the mid-dorsal rows. There are 9 frontoventral, 5 transverse and 4 caudal cirri. The macronucleus is an angular C-shape with the anterior micronucleus in a shallow depression of the macronucleus.

Euplotes octocarinatus Carter, 1972

Euplotes octocarinatus is a recent addition to the genus and the only description available is that by Carter (1972).

DIAGNOSIS. *Euplotes octocarinatus* (Fig. 39) is a medium (80 μm long, 50 μm wide) freshwater ellipsoid species. The peristome is triangular in shape and it extends about halfway down the length of the body. The AZM is narrow as it emerges from the dorsal anterior collar and then widens towards the middle of the body, it contains about 36–42 membranelles. There is a well-defined pouch to the right of the peristomial cavity. The dorsal surface is convex and ridged. The dorsal

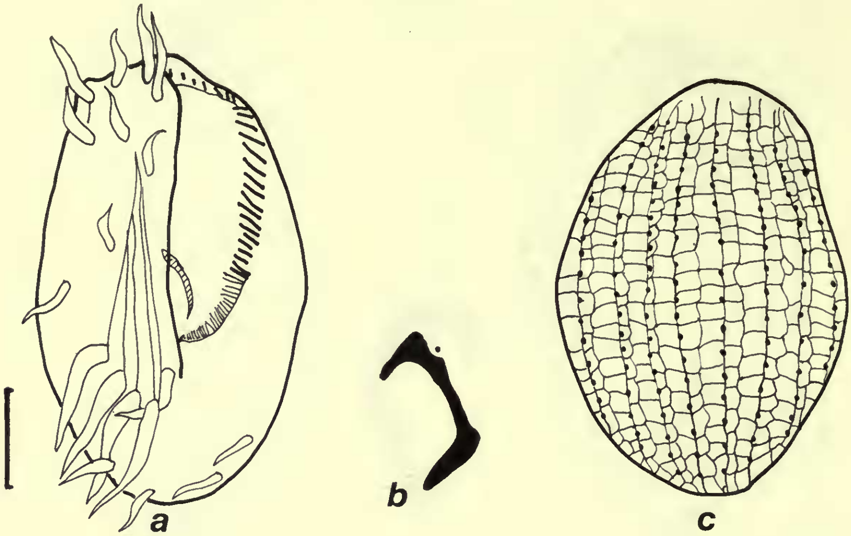

FIG. 38. *Euplotes diadaleos*. a. Ventral aspect. b. Nuclei. c. Dorsal argyrome. (After Diller & Kounaris, 1966.)

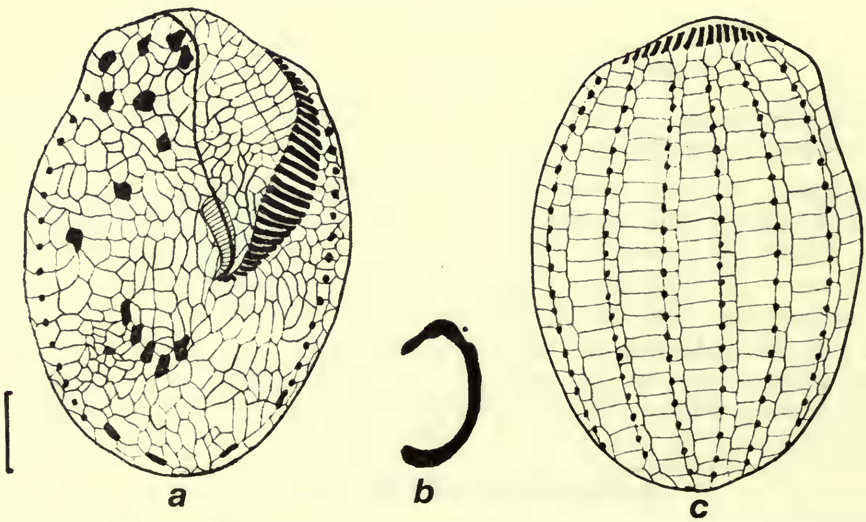

FIG. 39. *Euplotes octocarinatus*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Carter, 1972.)

argyrome is of the double-patella type with 8 dorsolateral kineties containing 18–21 cilia in the mid-dorsal rows. There are 9 frontoventral, 5 transverse and 4 caudal cirri, although occasionally there may be 5 caudals. The macronucleus is a wide-mouthed C-shape and there is a small adjacent micronucleus.

Euplotes patella (Müller, 1773) Ehrenberg, 1838

Euplotes patella has a long historical record and has several synonyms; it was first described by Müller (1773) under the name *Trichoda patella* and subsequently by Müller (1786) as *Kerona patella*. It was called *E. patella* by Ehrenberg (1838) but was then named *Ploesconia patella* by Dujardin (1841). Several other early authors also refer to this species and much later Kahl (1932) found it necessary to subdivide the species into five forms which he named formae *typicus*, *latus*, *alatus*, *planctonicus* and *variabilis* (Stokes, 1887). These subdivisions were criticized by Pierson (1943) who observed that the first four of the above-mentioned forms were simply temporary varieties that could be found within clonal cultures of *E. patella*. Pierson (1943) also stated that *E. patella* forma *variabilis* Kahl, 1932 was in fact a variety of *E. eurystomus*. It was not until the work of Tuffrau (1960) that *E. patella* could readily be distinguished from *E. eurystomus* but with silver-line preparations this is now quite a simple task.

DIAGNOSIS. *Euplotes patella* (Fig. 40) is a large (110 μm long, 65 μm wide) oval freshwater species that has a pronounced blunt posterior end. The peristome is large, wide and almost triangular in appearance extending just over halfway down the length of the body. The AZM is narrow, evenly curved and contains 44–50 membranelles. The dorsal argyrome is of the double-patella type with 9 dorsolateral

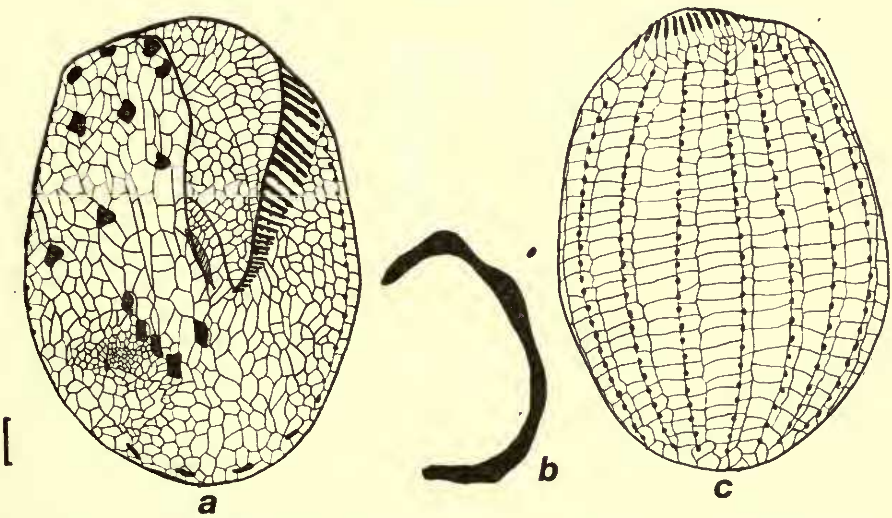

FIG. 40. *Euplotes patella*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Tuffrau, 1960.)

kineties containing about 26 cilia in the mid-dorsal rows, although it should be noted that Carter (1972) observed rather fewer cilia (13–19). There are 9 frontoventral, 5 strong transverse and 4 caudal cirri. The macronucleus is an open C-shape with slightly pointed extremities. The upper arm points down slightly and bears several indentations. The micronucleus is situated anteriorly.

Euplotes raikovi Agamaliev, 1966

This species was first described by Agamaliev (1966) and slightly amended later (Agamaliev, 1967).

DIAGNOSIS. *Euplotes raikovi* (Fig. 41) is a small (50–60 μm long) marine ciliate whose outline body shape is broadly rounded. The peristome is of medium size and extends about $\frac{2}{3}$ down the body length. The AZM is regularly curved and contains 30–35 membranelles. The dorsal argyrome is of the double-patella type with 7 dorsolateral kineties bearing up to 11 cilia in the mid-dorsal rows. There are 7 or 8 frontoventral, 5 transverse and 3 caudal cirri. The macronucleus was originally reported to be a simple C-shape by Agamaliev (1966) but less like a C in his later description (Agamaliev, 1967) (see Fig. 41). The micronucleus is small and situated anteriorly.

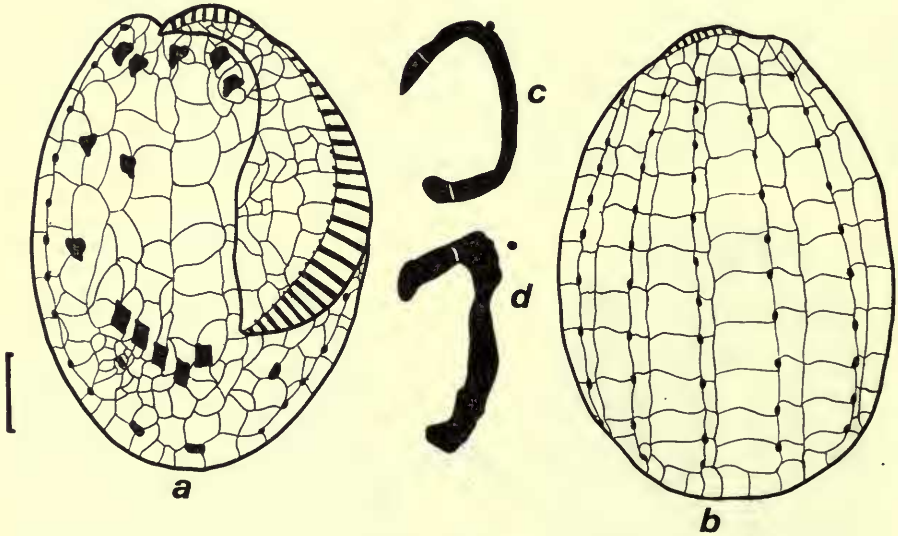

FIG. 41. *Euplotes raikovi*. a. Ventral argyrome. b. Dorsal argyrome. (After Agamaliev, 1966.) c–d. Nuclei (after Agamaliev, 1966 and 1967 respectively).

Euplotes rariseta Curds, West and Dorahy, 1974

This species was first described by Borror (1963) but he called it *E. moebiusi* Kahl, 1932. Curds, West and Dorahy (1974) isolated a marine hypotrich which in their opinion did not conform to any previous descriptions and named their organism *E.*

rariseta. Curds (1974) also described *E. moebiusi* Kahl, 1932 which agreed precisely with the descriptions of Kahl (1932) but differed in several respects from *E. rariseta.* There seems little doubt that *E. moebiusi* Borror, 1963 is the species described by Curds *et al.* (1974) and that the *E. moebiusi* described by Curds (1974) conforms to the descriptions of Kahl (1932) and to the part of the silver-line system shown by Klein (1958).

DIAGNOSIS. *Euplotes rariseta* (Fig. 42) is a small (30–45 μm long, 20–31 μm wide) marine hypotrich with 10 frontoventral, 5 transverse and 3 caudal cirri. The cirrus below the AZM is stout. The ventral surface is heavily sculptured with 6 posteriorly projecting ridges. The dorsal surface has an argyrome of the double-patella type with 6 dorsolateral kineties carrying a maximum of 6 cilia in the mid-dorsal rows. The macronucleus is an irregular S-shape.

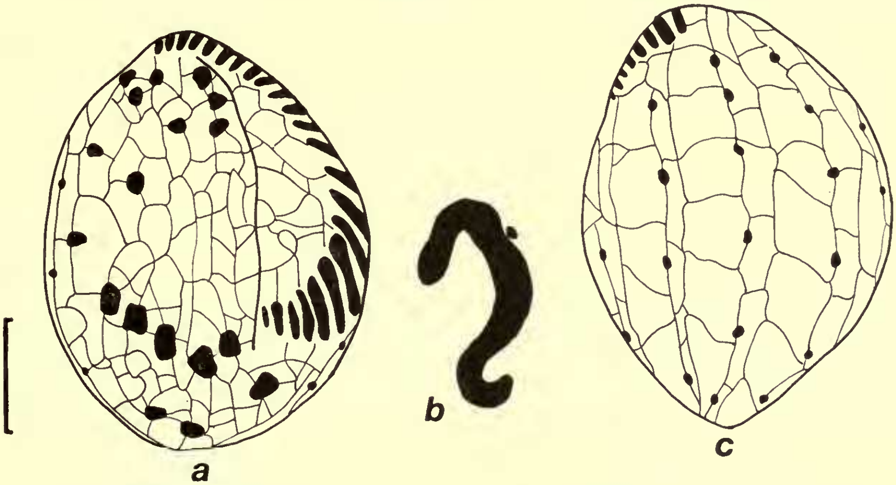

FIG. 42. *Euplotes rariseta.* a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Curds, West & Dorahy, 1974.)

Euplotes strelkovi Agamaliev, 1967

This species was described by Agamaliev (1967) from samples of sand taken from the Caspian Sea.

DIAGNOSIS. *Euplotes strelkovi* (Fig. 43) is a small (50 μm long, 40 μm wide) marine species that is particularly round in outline shape. The peristome is of medium size and the right margin is essentially straight. The AZM extends about $\frac{3}{4}$ down the body and is composed of 33–38 membranelles. The dorsal argyrome is of the double-patella type with 6 dorsolateral kineties bearing up to 10 cilia in the mid-dorsal rows. The small polygons of the dorsal argyrome are on the left of the kineties. There are 8 frontoventral, a unique 6 transverse and 3 caudal cirri. The macronucleus is an irregular open C-shape with a compact micronucleus situated anteriorly.

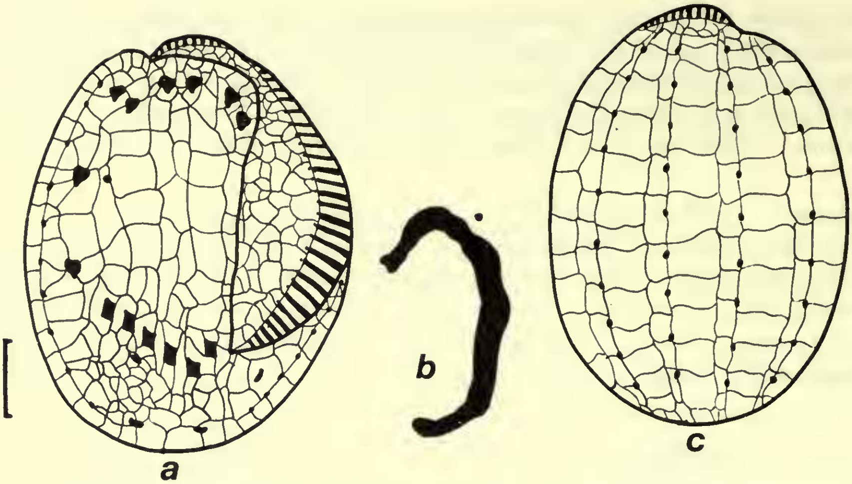

FIG. 43. *Euplotes strelkovi*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Agamaliev, 1967.)

Euplotes zenkewitchi Burkovsky, 1970

This species was first described by Burkovsky (1970) and more recently by Agamaliev (1972).

DIAGNOSIS. *Euplotes zenkewitchi* (Fig. 44) is a medium (80 μm long, 50 μm wide) marine elongate hypotrich. The peristome is quite narrow and elongate extending just over halfway down the body. The AZM contains 50–55 membranelles. The dorsal argyrome is of the double-patella type except that the narrow polygons lie

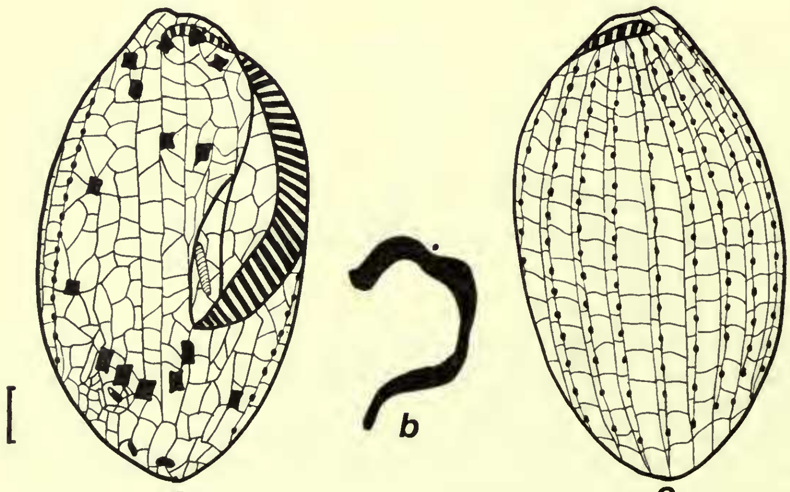

FIG. 44. *Euplotes zenkewitchi*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Burkovsky, 1970.)

on the left of the kineties. There are 10 dorsolateral kineties with up to 18 dorsal cilia in the central rows. There are 9 frontoventral, 5 transverse and 3 or 4 caudal cirri. The macronucleus is C-shaped with a posteriorly pointing tail. The micronucleus is in an anterior position.

Section D. Key to species with a multiple type dorsal argyrome

43 a Polygons of dorsal argyrome approximately equal in shape and size, with 9 or 10 dorsolateral kineties **44**

b Polygons of dorsal argyrome of two types, squat polygons bordering the dorsal cilia and very long polygons between squat ones, with 6 dorsolateral kineties *E. tegulatus*

44 a 10 frontoventral cirri, 9 dorsolateral kineties with 11–20 dorsal cilia in central rows *E. indentatus*

b 9 frontoventral cirri, 10 dorsolateral kineties with over 30 dorsal cilia in central rows *E. muscicola*

Section D. Descriptions of species

Euplotes indentatus Carter, 1972

This species is a recent addition to the species of the genus and its description relies upon that of Carter (1972).

Diagnosis. *Euplotes indentatus* (Fig. 45) is a small (60 μm long, 45 μm wide) marine species. The body is distinctly oval in outline shape with a prominent anterior notch in the upper border of the dorsal surface. The AZM is composed of 42–48 membranelles and extends ⅔ of the body length. There are 10 frontoventral, 5 transverse and 4 caudal cirri. The dorsal surface is convex and deeply ridged.

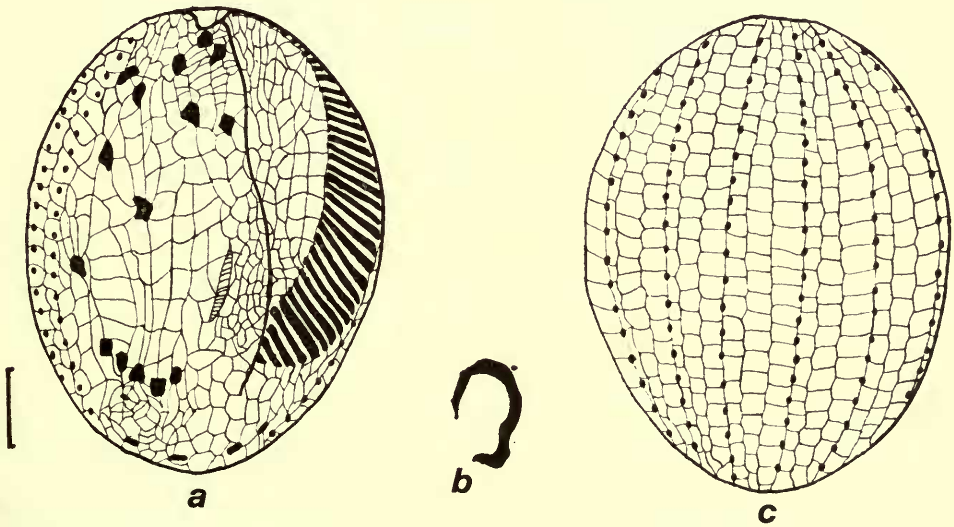

Fig. 45. *Euplotes indentatus*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Carter, 1972.)

The dorsal argyrome is of the multiple type with three regular rows of polygons between the kineties. There are 9 dorsolateral kineties bearing a maximum of 15–21 cilia in the mid-dorsal rows. The macronucleus is a closed C-shape with the anterior micronucleus situated in a slight invagination.

Euplotes muscicola Kahl, 1932

Although this species was intially described by Kahl (1932) and its encystment by Fauré-Fremiet, Gauchery and Tuffrau (1954) a complete description was not available until Tuffrau (1960) published its silver-line system.

Diagnosis. *Euplotes muscicola* (Fig. 46) is a medium (60–70 μm long) elongate oval freshwater hypotrich. The peristome is long and occupies about $\frac{3}{4}$ of the anterior left side of the ventral surface. The AZM contains about 35 membranelles. There are 9 frontoventral, 5 transverse and 4 caudal cirri. The dorsal argyrome is of the multiple type and consists of 4 regular rows of small polygons between the kineties. There are 10 dorsolateral kineties bearing up to about 35 cilia in the mid-dorsal rows. The macronucleus is an open C-shape with a compact micronucleus situated about halfway down its left side.

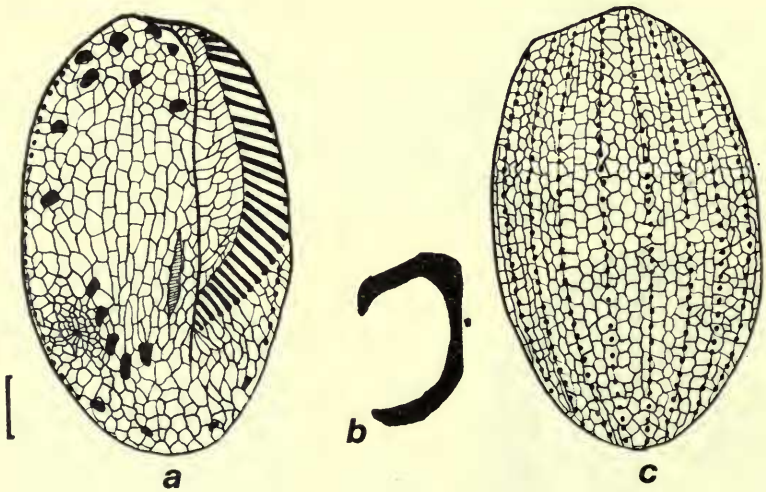

Fig. 46. *Euplotes muscicola.* a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Tuffrau, 1960.)

Euplotes tegulatus Tuffrau, 1960

The description of this species relies solely upon that of the original by Tuffrau (1960).

Diagnosis. *Euplotes tegulatus* (Fig. 47) is a large (116 μm long) marine species that has an elongate ellipsoidal shape. The dorsal surface is prominently sculptured with 3 or 4 ridges. The ventral surface has a pronounced longitudinal ridge that

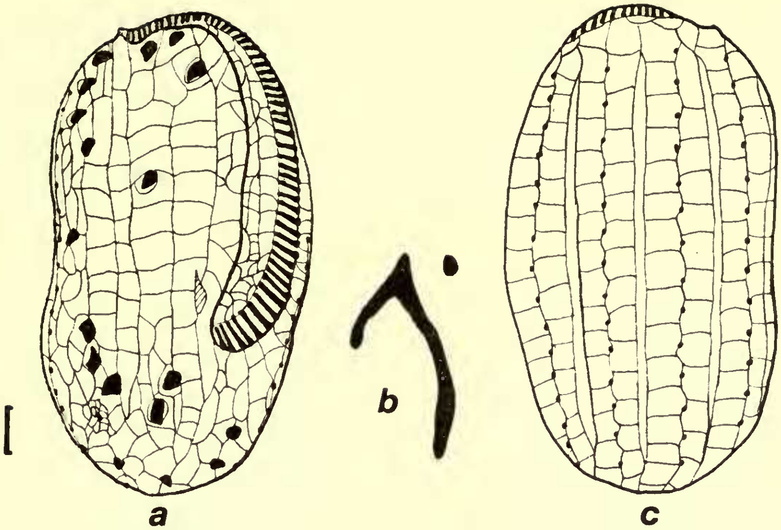

FIG. 47. *Euplotes tegulatus*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Tuffrau, 1960.)

ends both posteriorly and anteriorly in spines. The anterior ventral spine is short but projects forward beyond the margin of the body. The peristome is long and curved extending down $\frac{2}{3}$ of the body length. The AZM consists of about 55 membranelles. The dorsal argyrome is of the multiple type but is unique in that there are two longitudinal fibrils between the dorsolateral fibrils. There are 6 dorsolateral kineties with up to 15 cilia in the mid-dorsal rows. There are 9 frontoventral, 5 transverse and 4 caudal cirri. The macronucleus is highly angular in appearance; it is composed of two arms joined anteriorly at an acute angle. The micronucleus is very large for the genus (7–8 μm diameter) and is situated anteriorly on the left of the macronucleus.

SECTION E. KEY TO SPECIES WITH A COMPLEX TYPE DORSAL ARGYROME

45 a 10 frontoventral cirri **46**
b 9 frontoventral cirri **47**
46 a 7 dorsolateral kineties, complex dorsal argyrome network interspersed with regular rows of polygons . . . . *E. moebiusi*
b 11 dorsolateral kineties, complex dorsal argyrome network complete or partially so *E. mutabilis*
(N.B. This species is undergoing reorganization – its description is given in Section A, p. 14.)
47 a 7 dorsolateral kineties with 11–15 cilia in mid-dorsal rows . . . . . *E. gracilis*
b 8 dorsolateral kineties with 20 or more cilia in mid-dorsal rows **48**
48 a 20–25 dorsal cilia in central kineties, AZM with 30–35 membranelles . *E. muscorum*
b More than 25 (usually 25–45) cilia in mid-dorsal kineties, AZM with 40–45 membranelles . . . . *E. elegans*

Section E. Descriptions of the species

Euplotes elegans Kahl, 1932

This species was originally described briefly by Kahl (1932) and then redescribed in detail by both Tuffrau (1960) and Carter (1972). Kahl (1932) and Dragesco (1960) have also described a form of this species, *E. elegans* forma *littoralis*, but this differs little from *E. elegans* and such a differentiation does not appear to be warranted.

Diagnosis. *Euplotes elegans* (Fig. 48) is a medium (80 μm long, 55 μm wide) euryhaline species that has an oval outline shape. The peristome is large and extends about ¾ down the length of the body. The AZM is composed of 40–45 strong membranelles. There are 9 frontoventral, 5 transverse and 3 or 4 caudal cirri. The original description by Kahl (1932) appears to be the only observation of the presence of 3 caudal cirri. The dorsal argyrome is of the complex type consisting of many irregular polygons. There are 8 dorsolateral kineties with a maximum of 30–46 dorsal cilia in the central kineties. The left lateral kinety is short with only 4–8 cilia and is easily overlooked. The macronucleus is C-shaped with a small, blunt, knob-like projection on the upper arm and both arms taper to points. The micronucleus is small and compact.

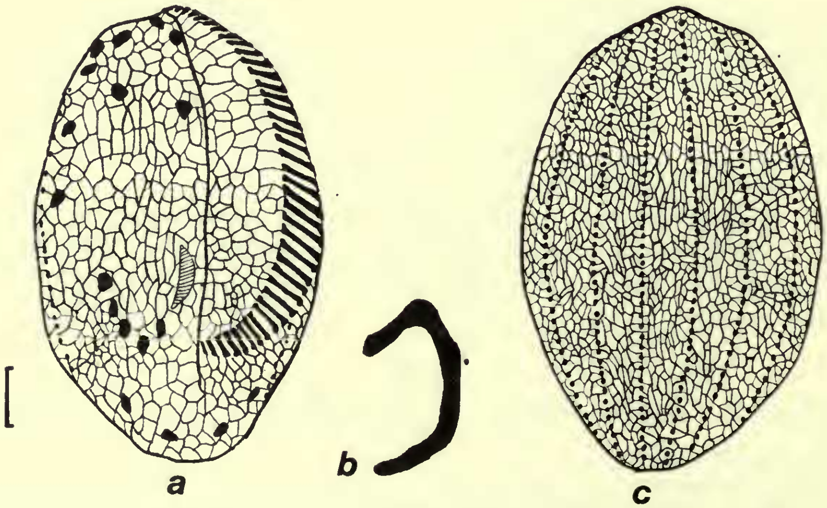

Fig. 48. *Euplotes elegans*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Tuffrau, 1960.)

Euplotes gracilis Kahl, 1932

First briefly described by Kahl (1932) this species was more fully described by Tuffrau (1960).

Diagnosis. *Euplotes gracilis* (Fig. 49) is a small (37–50 μm long) freshwater species that has an elongate oval shape. The peristome is very deep and extends about $\frac{3}{4}$ down the length of the body. The AZM is composed of 30–35 membranelles. There are 9 frontoventral, 5 transverse and 4 caudal cirri. The frontoventral cirri are very long and styliform whereas the caudals are thin. The dorsal argyrome is of a complex nature consisting of an irregular assemblage of polygons between the 7 dorsolateral kineties. There are 10–13 large kinetosomes in the mid-dorsal kineties. The macronucleus is C-shaped and the micronucleus is situated approximately $\frac{1}{3}$ of the way down its left edge.

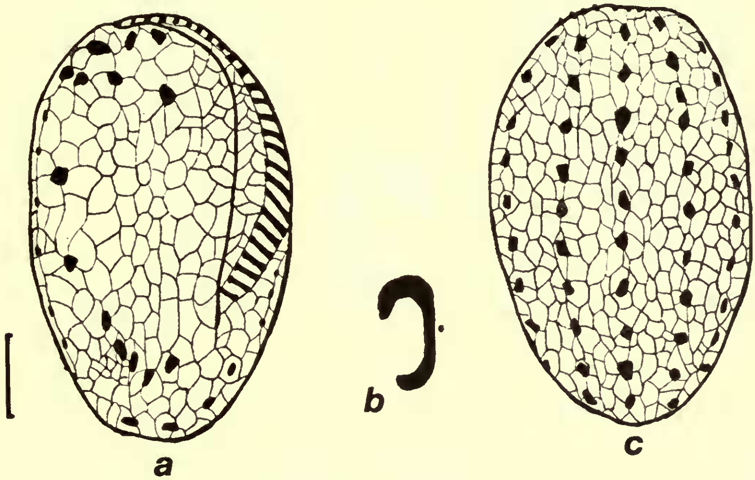

FIG. 49. *Euplotes gracilis*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Tuffrau, 1960.)

Euplotes moebiusi Kahl, 1932

Until recently *E. moebiusi* could only be identified from the brief and incomplete descriptions of Kahl (1932). Borror (1963) described an organism as *E. moebiusi* but this was later shown by Curds, West and Dorahy (1974) to be a new species, *E. rariseta*. Photographs of part of the silver-line system were first published by Klein (1958) in order to demonstrate the 'dry' silver method and although these were not sufficiently comprehensive for identification purposes they do conform with the silver-line systems described by Curds (1974). Tuffrau (1960) considered *E. moebiusi* to be a synonym of *E. charon* Ehrenberg, 1830.

DIAGNOSIS. *Euplotes moebiusi* (Fig. 50) is a medium (60 μm long, 40 μm wide), ovoid euryhaline hypotrich with 10 frontoventral, 5 transverse and 4 caudal cirri. The ventral surface is heavily sculptured with 7 ridges and the dorsal surface with 5 longitudinal ridges. The AZM is composed of 35–40 membranelles which extend $\frac{2}{3}$ the length of the cell. The dorsal argyrome is unique amongst those species described to date ; there are 5 longitudinal rows of narrow polygons interspersed with an irregular network of larger polygons. The presence of the irregular network has been thought to be sufficient to place it within the 'complex' group until data concerning other species become available. There are 7 dorsolateral kineties bearing a maximum of 11 cilia in the mid-dorsal rows. The macronucleus is 3-shaped and the micronucleus is situated anteriorly.

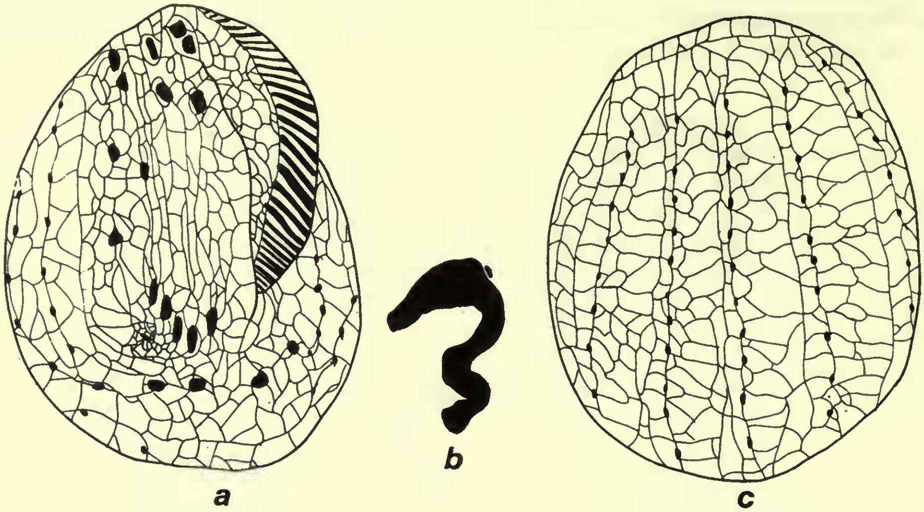

FIG. 50. *Euplotes moebiusi*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Curds, 1974.)

Euplotes muscorum Dragesco, 1970

This species was isolated from samples of moss collected in Africa by Dragesco (1970).

DIAGNOSIS. *Euplotes muscorum* (Fig. 51) is a small to medium (50–70 μm long) elongate freshwater species. The AZM contains approximately 30 membranelles and extends about ⅔ down the body. There are 9 frontoventral, 5 transverse and 4 long caudal cirri. The dorsal argyrome is of the complex type with many polygons arranged irregularly between the kineties. There are 8 dorsolateral kineties carrying 22–28 cilia in the mid-dorsal rows on the peaks of the longitudinal ridges. The macronucleus is C-shaped with the pointed right arm projecting posteriorly over halfway down the length of the body. The micronucleus is situated anteriorly almost in line with the central longitudinal axis of the body.

SECTION F. UNDEFINED SPECIES

The silver-line systems of the following seven recognizable species have not yet been described. Their descriptions are given in alphabetical order.

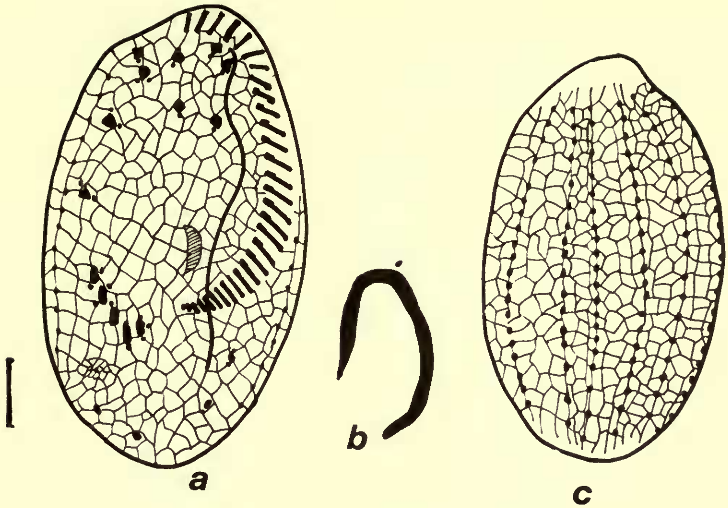

FIG. 51. *Euplotes muscorum*. a. Ventral argyrome. b. Nuclei. c. Dorsal argyrome. (After Dragesco, 1970.)

Euplotes aberrans Dragesco, 1960

This species was briefly and inadequately described by Dragesco (1960) from samples of marine sands but for several reasons may be regarded as a distinct species until further data are gathered.

DIAGNOSIS. *Euplotes aberrans* (Fig. 52) is a medium (70–80 μm long) marine ciliate whose shape is highly elongate. There is a distinct spike-like projection on the right of the peristomial collar. The dorsal surface bears 4 pronounced ridges and there are 2 major ones, amongst others, on the ventral surface which travel slightly transversally almost the entire length of the body. The peristome is long and narrow extending about $\frac{2}{3}$ down the body and is composed of about 50 membranelles. There are 8 frontoventral cirri which is a feature shared by only three other species (*E. strelkovi*, *E. raikovi* and *E. poljanskyi* – all of which have differently shaped macronuclei). There are 5 transverse cirri in two groups and 4 caudals. There is a very large subequatorial vacuole which has not yet been seen to contract. The macronucleus is horseshoe shaped whose ends almost meet one another. The micronucleus lies within a definite indentation in the anterior of the macronucleus.

Euplotes novemcarinata Wang, 1930

Recognition of this species relies upon the single description by Wang (1930).

DIAGNOSIS. *Euplotes novemcarinata* (Fig. 53) is a small to medium (60–75 μm long) freshwater ciliate whose deep ridges are distinctive. The overall outline shape of the body is oval but there is a wing-like extension on the left side due to the projection of one of the ridges. There are 9 longitudinal ridges, 5 are dorsal, 1 lateral and

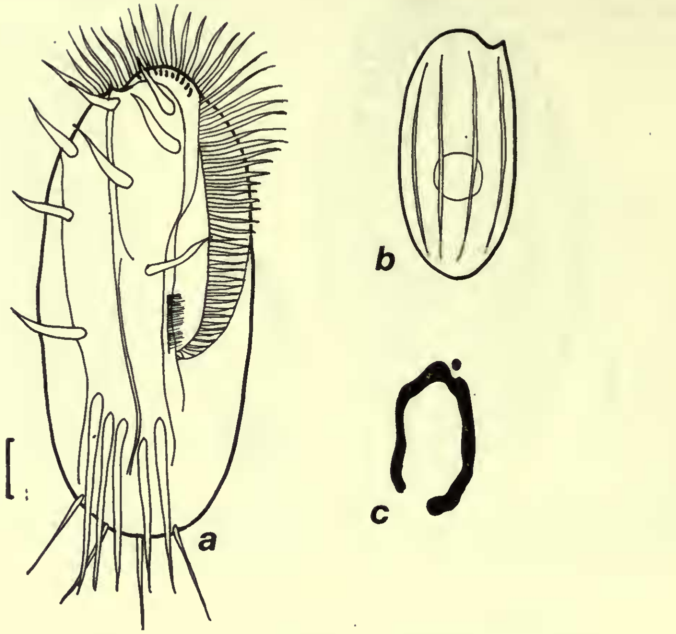

Fig. 52. *Euplotes aberrans.* a. Ventral aspect. b. Dorsal aspect. c. Nuclei. (After Dragesco, 1960.)

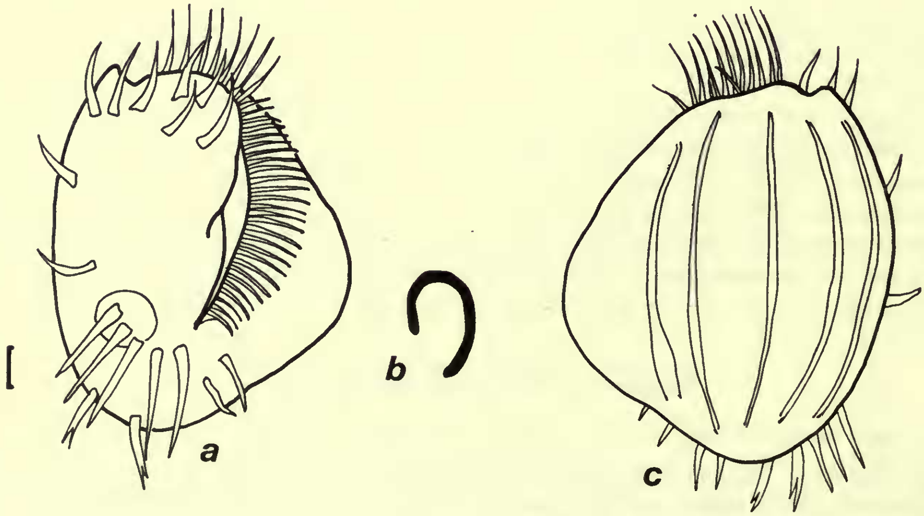

Fig. 53. *Euplotes novemcarinata.* a. Ventral aspect. b. Macronucleus. c. Dorsal aspect. (After Wang, 1930.)

3 less prominent ones are restricted to the ventral surface. The anterior end of the body has a concave notch and the peristome extends down $\frac{2}{3}$ of the body length. There are 9 frontoventral, 5 transverse and 4 caudal cirri. The macronucleus is C-shaped.

Euplotes roscoffensis Dragesco, 1966

Although this species was not described until 1966 it was in fact first studied in 1950 long before the importance of silver preparations for *Euplotes* taxonomy was realized. However, because the right-hand border of the peristome is so distinctive this should be an easily identifiable species.

DIAGNOSIS. *Euplotes roscoffensis* (Fig. 54) is a small to medium (60–70 μm long) ovoid marine ciliate. The right border of the peristome is straight until it reaches the level of the undulating membrane just below the middle of the cell, here the peristome border bears a distinctive deep invagination or pocket (Fig. 53) which appears to be a unique character. The AZM is composed of 40–50 membranelles. There are 10 frontoventral, 5 transverse and 4 caudal cirri. The large contractile vacuole which is situated in the proximity of transverse cirrus VI 1 often has several small satellite vacuoles surrounding it. The macronucleus is C-shaped with a club-like structure at the posterior end. The micronucleus is small, round and situated close to the anterior left edge of the macronucleus.

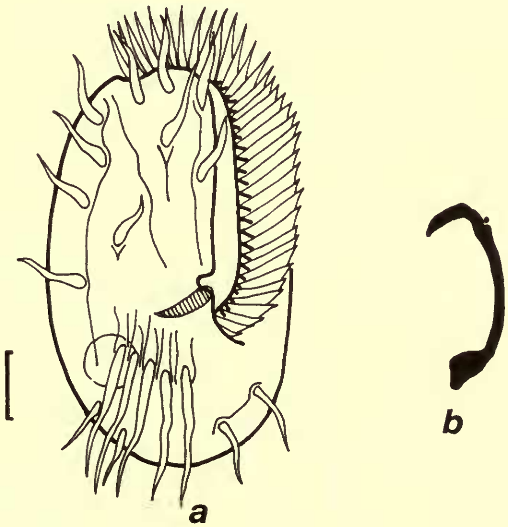

FIG. 54. *Euplotes roscoffensis*. a. Ventral aspect. b. Nuclei. (After Dragesco, 1966.)

Euplotes rotunda Gelei, 1950

The identity of this species relies upon the single brief and inadequate description of Gelei (1950).

DIAGNOSIS. *Euplotes rotunda* (Fig. 55) is a small (50 μm long, 40 μm wide) round freshwater species. The peristome extends down to about the centre of the body and the AZM carries approximately 25 membranelles. There are 8 dorsolateral kineties with about 10 cilia in the mid-dorsal rows. There are 9 frontoventral, 5 transverse and 3 caudal cirri. The macronucleus is a flattened **3**-shape.

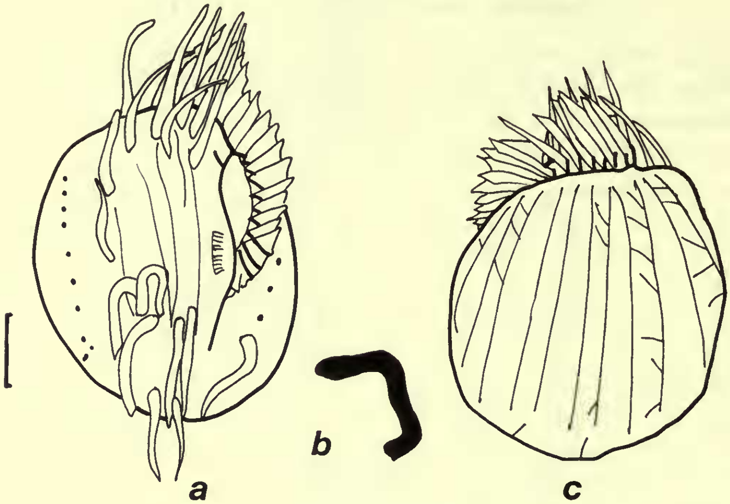

FIG. 55. *Euplotes rotunda*. a. Ventral aspect. b. Macronucleus. c. Dorsal aspect. (After Gelei, 1950.)

Euplotes terricola Penard, 1922

This species relies upon the single description by Penard (1922) who found it in samples of moss. Tuffrau (1960) was unconvinced that this organism is in fact a member of the genus but both Kahl (1932) and Borror (1972) include it in their works.

DIAGNOSIS. *Euplotes terricola* (Fig. 56) is a small to medium (60–65 μm long) freshwater species that is generally oval in outline but tends to narrow posteriorly to a blunt point. The peristome is relatively short and extends just to the centre of the body and there appear to be somewhere in the order of 20 membranelles in the AZM. The dorsal surface seems to have 6 ridges and there are 9 frontoventral and 5 transverse cirri. According to Kahl (1932), there are 10 caudal cirri although Penard (1922) originally described these as being very fine marginal cirri. The macronucleus is a simple hoop-shape but the micronucleus is illustrated as lying inside the curve of the macronucleus which is an unusual feature for the genus. It is apparent that there are many doubts about this organism and it requires redescription before it can be adequately assessed.

Euplotes thononensis Dragesco, 1960

Recognition of this organism relies upon the brief and inadequate description by Dragesco (1960).

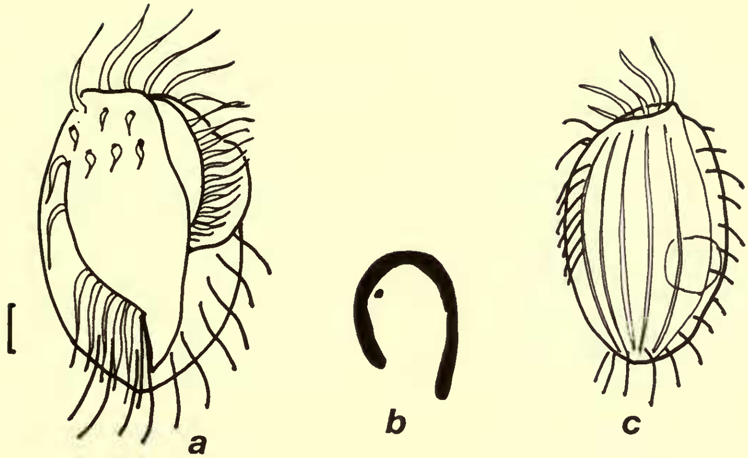

Fig. 56. *Euplotes terricola*. a. Ventral aspect. b. Nuclei. c. Dorsal aspect. (After Penard, 1922.)

Diagnosis. *Euplotes thononensis* (Fig. 57) is a medium to large (90 μm long) marine species whose outline shape is oval except for the pronounced projecting peristomial collar. The dorsal surface carries 12 longitudinal furrows and there appear to be about 11 dorsal cilia. The peristome is wide but extends less than half-way down the cell. There are 9 frontoventral cirri, one of which originates on the peristome border beneath the peristomial collar. There are 5 transverse and 4 caudal cirri. A group of 3 contractile vacuoles is positioned close to the transverse cirri. The macronucleus is an open C-shape with the micronucleus in an anterior position.

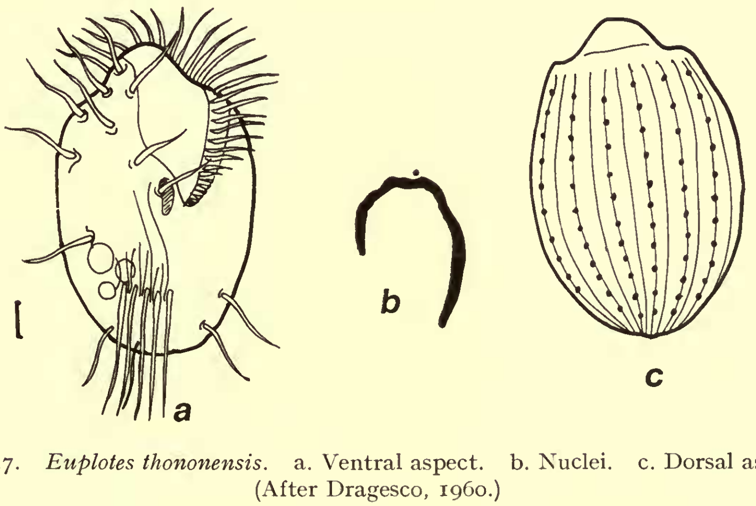

Fig. 57. *Euplotes thononensis*. a. Ventral aspect. b. Nuclei. c. Dorsal aspect. (After Dragesco, 1960.)

Euplotes woodruffi Gaw, 1939

This species was first described by Gaw (1939) and more recently by Borror (1963). Unfortunately its silver-line system is still unknown but its unique macronucleus enables it to be easily recognized.

Diagnosis. *Euplotes woodruffi* (Fig. 58) is a large (145 μm long) euryhaline oval species with a well-defined peristomial collar. The peristome is large, triangular in shape and extends about $\frac{2}{3}$ of the way down the body. The AZM is composed of 60–70 membranelles. The dorsal surface is sculptured with 8–10 grooves and there are 8 dorsolateral kineties with about 60 closely set cilia in the central rows. There are 9 frontoventral, 5 transverse and 4 caudal cirri. The unique macronucleus is T- or Y-shaped with the micronucleus in an anterior position.

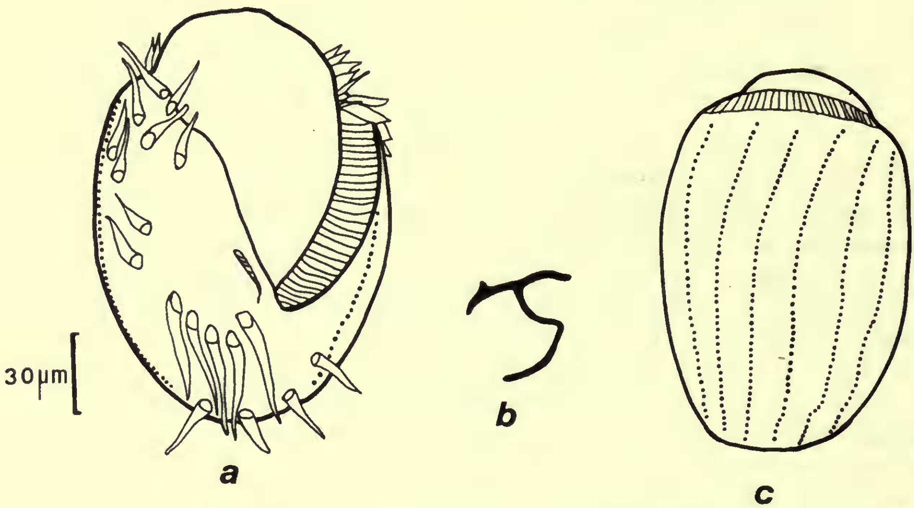

Fig. 58. *Euplotes woodruffi.* a. Ventral aspect. b. Macronucleus. c. Dorsal aspect. (After Borror, 1963.)

APPENDIX I CHECK-LIST AND INDEX OF SPECIES AND SYNONYMS

Addendum

Since the preparation of this manuscript it has been brought to the author's notice that a silver-line preparation of *E. woodruffi* has been published (Magagnini & Nobili, 1964). It is of the double-eurystomus type with 8 dorsolateral kineties and 25 middorsal cilia. In the existing key these characters would lead to *E. aediculalus* and *N. eurystomus*. All three species may be easily distinguished by their nuclear features.

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